SCIENCE LIBRARY

128

JUL 9 '31

VOLUME 21 NUMBER 7

JULY, 1931

Phytopathology

An International Journal

Official Organ of
The American Phytopathological Society

CONTENTS

Resistencia comparativa a la Tilletia levis Kühn, del trigo, en la Argentina ..... RAIMUNDO NIEVES 705

Bordeaux mixture as a factor increasing drouth injury. J. D. WILSON and H. A. RUNNELS 729

Anthracnose of strawberry caused by Colletotrichum fragariae, n. sp. A. N. BROOKS 739

Influence of mosaic infection on tomato yields. J. W. HEUBERGER and A. J. MOYER 745

Heterothallism in corn rust and effect of filtering the pycnial exudate. GEORGE B. CUMMINS 751

New or unusual symptoms of virus diseases of raspberries. GEORGE L. ZUNDEL 755

Phytopathological Notes 759

Book Review 763

Price { $6.00 per year, United States and dependencies, Mexico and Cuba
$6.25 per year, Canada
$6.50 per year, elsewhere

PUBLISHED MONTHLY BY THE SOCIETY

OFFICE OF PUBLICATION

COR. LIME AND GREEN STREETS, LANCASTER, PA.

Entered at the post-office in Lancaster, Pa., as second-class matter.

DIFCO

Dehydrated Culture Media
for the
Plant Pathologist and Mycologist

Bacto-Malt Agar
Bacto-Corn Meal Agar
Bacto-Potato Dextrose Agar
Bacto-Lima Bean Agar
Bacto-Bean Pod Agar
Bacto-Prune Agar
Bacto-Malt Extract Agar (Synthetic)

Specify "DIFCO"

THE TRADE NAME OF THE PIONEERS
In the research and development of Bacto-Peptone and Dehydrated Culture Media

DIFCO LABORATORIES
DETROIT, MICHIGAN, U. S. A.
BACTERIOLOGICAL DIVISION of DIGESTIVE FERMENTS CO.

FOUNDED 1839
GRASSELLI
REG. U.S. PAT. OFF.

GRASSELLI MANGANAR DUST

MANGANAR DUST for Roses is the outcome of several years research work carried on jointly by the Department of Plant Pathology of the Ohio State Experiment Station and the Research Department of the Grasselli Chemical Company. This product was developed to control Black Spot and Mildew on roses and leaf-eating insects as well. It has proven to be one of the most effective controls known for Black Spot on roses, and has controlled mildew and leaf-eating insects. It has also proven effective as a fungicide and insecticide on Snapdragons, Asters, Hollyhocks and Carnations.

Entomologists are invited to write for full information

THE GRASSELLI CHEMICAL COMPANY
Cleveland Incorporated Ohio

GRASSELLI GRADE

Arsenate of Lead	Bordeaux Mixture	Sulphate of Nicotine
Calcium Arsenate	Dusting Sulphur	Casein Spreader
	Monohydrated Copper Sulphate	

Purchase from our advertisers. Mention Phytopathology when ordering.

Science
Wahr

PHYTOPATHOLOGY

An International Journal
Official Organ of The American Phytopathological Society

EDITORS

H. B. HUMPHREY, Editor in Chief, U. S. Department of Agriculture, Washington, D. C.
H. M. QUANJER, Editor for Europe, Instituut voor Phytopathologie, Wageningen, Holland.
J. W. ROBERTS, U. S. Department of Agriculture, Washington, D. C.
A. J. RIKER, University of Wisconsin, Madison, Wis.

ASSOCIATE EDITORS

CHARLES DRECHSLER, U. S. Department of Agriculture, Washington, D. C.
G. L. PELTIER, College of Agriculture, University of Nebraska, Lincoln, Nebr.
L. O. KUNKEL, Boyce Thompson Institute for Plant Research, Inc., Yonkers, N. Y.
F. D. HEALD, State College of Washington, Pullman, Wash.
RUTH F. ALLEN, University of California, Berkeley, Calif.
MARY K. BRYAN, U. S. Department of Agriculture, Washington, D. C.
L. R. HESLER, University of Tennessee, Knoxville, Tenn.
WM. H. WESTON, JR., Harvard University, Cambridge, Mass.
D. L. BAILEY, University of Toronto, Toronto, Canada.
G. H. GODFREY, University of Hawaii, Honolulu, Hawaii.
W. B. TISDALE, Agricultural Experiment Station, Gainesville, Fla.
MARGARET NEWTON, Manitoba Agricultural College, Winnipeg, Canada.

BUSINESS MANAGEMENT

F. C. MEIER, Business Manager, U. S. Department of Agriculture, Washington, D. C.
J. F. ADAMS, Advertising Manager, Delaware Agricultural Experiment Station, Newark, Del.

NOTICES

Subscription price. $6.00 per year United States and dependencies, Mexico and Cuba; Canada $6.25; other countries $6.50; current single numbers 50 cents. The journal is issued monthly beginning with Volume VIII, January, 1918.

Advertisements. Rates may be secured from business management. No indorsement of any statement of claims made in advertisements is assumed by this journal or by The American Phytopathological Society.

Requests to supply copies of the journal must be made within 60 days from date of issue. Date of issue January 15 and monthly thereafter.

Separates. No gratis copies are supplied. A printed schedule of prices is submitted with the proof, and authors may secure separates by placing an order on the blanks provided when proof is returned.

Back Volumes X to XX, inclusive, may be obtained unbound at $7.00 per volume. All other volumes obtainable only in broken numbers.

Separate Copies, $2.00 each, of Volumes I to VII, inclusive; 60 cents each for separate copies of all other volumes. The following numbers of Volumes I to VII are obtainable: Volume I, Nos. 4, 5, 6; Volume II, Nos. 1, 5, 6; Volume III, Nos. 5, 6; Volume VII, Nos. 3, 4, 5. No. 1 of Volume VIII and No. 1 of Volume IX are not obtainable.

Manuscript may be sent to the nearest member of the editorial board. Clearness, brevity, and conciseness are essential. In form and style, such as punctuation, spelling, and use of italics manuscripts should conform to the best usage in recent numbers of this journal. Manuscripts should be typed on one side of the paper, double spaced, and sent

unfolded. All papers longer than four printed pages should include a summary. The name and address of the institution at which the work was done should be included at the end of the summary. All footnotes should be numbered consecutively with arabic numerals except in tables, where small letters should be used. Each table should have a heading stating clearly and concisely its contents. References to literature should be made as footnotes only when four or less citations are given. The simplified method of citing literature used in recent numbers of this journal should be followed. References in "Literature Cited" should be listed alphabetically and numbered consecutively.

Illustrations necessarily must be limited in number, and photographs, to reproduce satisfactorily, must be of the best quality. Authors desiring unusual numbers of illustrations or special types of illustrations will be asked to bear part of the expense. All illustrations are reproduced on the same grade of paper and will be run as text figures wherever possible. Plates should be used only for a number of small illustrations which can not be run conveniently as individual text figures. Individual illustrations within a plate should be designated by letters to avoid confusion with text figures which are designated by arabic numerals. Authors should arrange plates to conform to page size and shape (4½ inches by 7 inches) after making due allowance for reductions. Specific reference to each illustration must be made in the text. There should be a complete legend for each illustration. All legends should be on separate paper and not on the illustration itself.

The responsibility for statements, whether of fact or opinion, rests entirely with the writers thereof.

The American Phytopathological Society

OFFICERS

President

M. W. GARDNER, Agricultural Experiment Station, La Fayette, Ind.

Vice-President

L. M. MASSEY, Cornell University, Ithaca, N. Y.

Secretary-Treasurer

F. C. MEIER, U. S. Department of Agriculture, Washington, D. C.

Councilors

H. P. BARSS, Agricultural Experiment Station, Corvallis, Oreg.
H. S. FAWCETT, Citrus Experiment Station, Riverside, Calif.
H. B. HUMPHREY, U. S. Department of Agriculture, Washington, D. C.
G. W. KEITT, University of Wisconsin, Madison, Wis.

Councilors Representing Divisions

C. E. OWENS, State College, Corvallis, Oreg. (Western Division.)
R. F. POOLE, Agricultural Experiment Station, State College Station, Raleigh, N. C. (Southern Division.)

PHYTOPATHOLOGY

VOLUME 21 NUMBER 7

JULY, 1931

RESISTENCIA COMPARATIVA A LA TILLETIA LEVIS KÜHN, DEL TRIGO, EN LA ARGENTINA[1]

ING°. AGR°. RAIMUNDO NIEVES[2]

OBJETO

Se iniciaron estos ensayos en 1928, como tarea preliminar de un vasto programa de investigación, tendiente a la creación de variedades de trigo muy resistentes a la caries (bunt), y de alto valor agricola-industrial.

Es sabido que existen métodos de desinfección absolutamente eficaces para prevenir esta enfermedad y desde la aparición de los métodos de curación "en seco" y de los polvos anticriptogámicos, puede decirse que la profiláxis de la caries es fácil, rápida y barata.

No obstante, la desidia de muchos agricultores y muchas veces la mala aplicación de los métodos curativos, hacen que esta enfermedad que pudiera extirparse del pais—asi como el carbón volador (loose smut)—por la sola y rigurosa aplicación de leyes profilácticas adecuadas, aparezca constantemente, con mayor o menor intensidad segun regiones.

Estas circunstancias, son las que quizás han movido a afirmar, a investigadores tales como Gaines, Tisdale et al. y Tingey, que pese al continuo mejoramiento de los métodos de curación, no se ha logrado un control satisfactorio de la plaga en regiones trigueras muy afectadas y que se hace entonces necesario concentrar esfuerzos, en la creación de variedades inmunes, ya que con su utilización, se puede alcanzar tranquila y seguramente, lo que quizás no lograra el empleo de leyes conminatorias.

DAÑOS

Los perjuicios que ocasioná la caries son de distinto orden:

(1) Disminuye el rendimiento unitario del cereal;

(2) Desvaloriza el producto;

(3) Puede provocar incendios en las trilladoras. Diversos autores afirman, que la mayoria de las explosiones en las trilladoras se producen en la trilla de trigos muy carbonudos;

[1] Contribución de la Estación Experimental de Guatraché (Pampa Central), de la Dirección General de Enseñanza y Fomento Agricola, del Ministerio de Agricultura de la Nación. Republica Argentina.

[2] Director de la Estación Experimental de Guatraché.

(4) Obliga a cambiar la semilla o al empleo forzoso de anticripto gámicos.

A su vez, dichos perjuicios, varian con el pais o regiones que se consideren, porque su distribución geográfica y virulencia, se hayan muy influenciados por el clima, naturaleza del suelo y caracteristicas biológicas de los trigos cultivados.

Dickson (11), establece que las pérdidas son apreciables en Kansas, mientras que en Wisconsin, la caries seria desconocida. Boerger (3), sin precisar el monto de las pérdidas sufridas por el Uruguay, establece que mientras la infección puede ser considerable en las siembras tempranas, llega a ser nula en las siembras muy tardias que coinciden además con periodos lluviosos.

Gaines (17), estima en 15 por ciento la pérdida anual sobre los trigos de invierno en solo Los estados de Washington, Oregon e Idaho, representando la misma un valor de 10 millones de dólares.

Tingey (47), estima que las pérdidas son muy grandes en los estados de las Rocky Mountains y cita que en 1925, treinta por ciento del trigo de Utah e Idaho, era "carbonudo."

Stevens y Hall (44), establecen que la pérdida anual en los EE.UU. por caries del trigo, es alrededor de 25 millones de bushels, a la que debe agregarse las pérdidas por explosiones de trilladoras, estimadas en un millón de dólares en dos años.

Marchal (30), la considera la enfermedad mas grave del trigo en Belgica y estima las pérdidas en 5 por ciento del valor total de la cosecha.

Delacroix y Maublanc (10), tambien la consideran una enfermedad muy extendida en Francia.

En Alemania, constituye una enfermedad de importancia económica, y a juzgar por los ensayos de Roemer, que transcribe Gaines (19), existen en ese pais formas fisiológicas de *Triticum tritici* Bjerk. (Wint.) de extrema virulencia, a las que han sucumbido trigos considerados inmunes en Estados Unidos.

En Palestina segun Reichert (40) habrian formas fisiológicas especialmente virulentas sobre los *Triticum durum* Desf. que en cambio no afectarian mayormente a los *T. vulgare.*

Algo semejante ha constatado recientemente Holton (23) en Minnesota, lo que le permitió afirmar, que las recientes epidemias de Caries sufridas por los *T. durum,* considerados generalmente muy resistentes a las Tilletias, en la "hard red spring wheat area," se deberian a la aparición de una nueva forma fisiológica, introducida a la region, o producida "in situ" por mutación o hibridación.

En la Argentina no se ha realizado una investigación completa tendiente a precisar las pérdidas anuales por las Tilletias, ni se ha establecido el area

de dispersión de las dos especies. Tampoco se han clasificado regiones de mayor o menor virulencia, ni establecido la existencia de formas fisiológicas especializadas, realizándose solo esfuerzos aislados en el exámen de aspectos particulares del problema.

No obstante puede afirmarse que en las regiones frias y con lluvias medianas a escasas, como son La Pampa, San Luis y el Oeste y Sud de Buenos Aires, las pérdidas son de consideración.

En las regiones trigueras lluviosas: Santa Fé, Entre Rios, Córdoba, Norte y Este de Buenos Aires, las Tilletias parecen no encontrar condiciones muy propicias para su evolución, siendo en cambio más común y perjudicial el *Ustilago tritici* (carbón volador)

ANTECEDENTES EN LA LITERATURA AGRICOLA

Investigaciones similares han sido realizadas por Farrer (15 y 16), Darnell-Smith (8) y McAlpine (31), en Australia; per Tubeüf (49), Kirchner (29) y Hecke (22), en Alemania; por Vavilov (51) en Rusia; por Donkin (12) en Sud Africa; por Gaines (17), Tisdale et al. (48), Stakman, Lambert y Flor (43), Tingey (47), Brentzel y Smith (4), etc. en EE. UU.

En nuestro pais, en 1928, Williamson (53) comunicó los resultados obtenidos en infecciones experimentales en un limitado número de variedades. Brunini (5) en 1930, comunica los resultados de los ensayos por él realizados en 1928 y 1929, con 12 trigos, todos ellos del grupo *T. vulgare,* y cultivados extensamente en el sud de Buenos Aires. Con excepción del Kanred, las restantes 11 variedades son de hábito primaveral o intermedio y se manifiestan muy susceptibles con promedios que oscilan entre 24 a 75 por ciento.

El Kanred se comporta como resistente, dando solo 12.2 por ciento de infección, como promedio de 5 repeticiones.

MATERIAL

Los trigos ensayados comprendian un total de 154 variedades pertenecientes a 5 subespecies. De ellas, 84 son de hábito invernal y 70 de hábito primaveral o intermedio. Los cuadros 1 y 2, presentan el detalle.

METODOS

La semilla se infectó poco antes de la siembra, con esporos de *Tilletia levis,* cosechados el año anterior sobre la variedad Tuzela.

Se empleó un exceso de esporos, agitándolos con la semilla, dentro de un tamborcito durante 5 minutos. Luego el polvo negruzco sobrante se eliminaba por tamizaje y las semillas ennegrecidas se alojaron en sobres numerados.

Las siembras se efectuaron en parcelas corridas, a 15 x 15 cm. entre plantas y en 3 épocas. Con excepción de 58 variedades, en las restantes 96, se obtuvieron de 160 a 180 plantas para cada una. En el cuadro 3, se presentan tabuladas, la distribución de las parcelas en cada época, el número de siembras individuales y el total de espigas examinadas.

Las variedades Florence y Tuzela, elejidas como testigos, la primera por su resistencia y la segunda por su enorme susceptibilidad, se repitieron en todas Las épocas y dentro de cada época en condiciones distintas.

CUADRO 1.—*Con la distribución de las variedades por su origen y hábito*

	Siembras en				
	Abril–Mayo		Julio		
Variedades	Hábito invernal	Hábito primaveral	Hábito invernal	Hábito primaveral	Totales
Comunes	10	4	...	4	18
De "pedigree"	15	2	...	6	23
Nuevos hibridos	13	...	...	51	64
Nuevas *L. puras*	42	...	4	3	49
Totales	80	6	4	64	154

CUADRO 2.—*Con la distribución de las variedades ensayadas, según su naturaleza genética*[a]

TRIGOS A 21 PARES DE CROMOSOMAS	
	v. graecum Körn. (tipo: Sary Maghis)
	v. erythrospermum Körn. (tipo: Kanred)
T. vulgare Vill.	*v. ferrugineum* Körn. (typo: Record)
143 vars.	*v. albidum* Körn. (tipo: Florence)
	v. lutescens Körn. (tipo: Ulka)
	v. milturum Körn. (tipo: Ruso pelón)
T. compactum Host.	
2 vars.	*v. icterinum* Körn. (tipo: Ballod Cheg.)
	v. melanopus Körn. (tipo: Tchersnouska)
T. durum Desf.	*v. coerulescens* Körn. (tipo: Tchersnoostaia)
6 vars.	*v. hordeiforme* Körn. (tipo: 45 b)
	v. erythromelan Körn. (tipo: Chargarod)
T. Turgidum L.	
1 var.	*v. pseudocervinum* Körn. (tipo: Alaska)
T. persicum Vav.	
1 var.	*v. fuliginosum* Zhk. (tipo: Fuliginoso)
T. dicoccum Schubl.	
1 var.	*v. atratum* Körn. (tipo: Black Winter)

[a] La clasificación adoptada es la consignada por el professor N. I. Vavilov, Jefe del Instituto de Botánica Aplicada y Mejoramiento de las Plantas, de Rusia, en sus "Studies on the Origin of Cultivated Plants" Leningrado, 1926.

CUADRO 3.—*Presentando la distribución de las parcelas en cada época de siembra, el número de siembras individuales, y el total de espigas examinadas*

Fecha de siembra	Numero de parcelas	Numero de variedades	Numero de siembras	Plantas por variedad	Numero de espigas
Abril 30	62	28	4,960	160	13,446
"	21	14	840	40	2,517
Mayo 5	47	44	1,880	40	13,455
Julio 17	68	68	12,240	180	29,776
Totales	198	154	19,920	.....	59,194

Se consideró cuidadosamente, el regimen climatérico durante la germinación (estas observaciones las hemos comunicado en otro trabajo, 34).

Al verificarse el recuento de las espigas enfermas se observó el criterio, que una sola espigueta infectada bastaba para considerar en ese estado a toda la espiga. Este criterio riguroso solo abulta los porcentajes en las variedades muy resistentes, que son las que generalmente presentan espigas en esas condiciones.

Los porcentajes dados en las planillas que se acompañan expresan la proporción de espigas enfermas sobre el total. No se consideró el porcentaje en "plantas infectadas," ni el porcentaje de "infección individual," tal como los presentan Gaines (17) y nosotros en otros trabajos (34 y 36).

Advertencia.—Los resultados aqui comunicados se obtuvieron en 1928.

En 1929, repetimos éstos ensayos, pero la terrible sequia que aflijió La Pampa, ese año, terminó con ellos.

En 1930, se han vuelto a repetir, multiplicando el número de repeticiones y el de variedades bajo control.

El deseo de no demorar mas la publicidad de resultados que conceptuamos interesantes, por tratarse del primer ensayo realizado en gran escala en la Argentina, justifica su presentación en este momento.

RESULTADOS

(I) *Influencia sobre la infección, de la temperatura y humedad durante la germinación. Sus relaciones con las épocas de siembra.*—Como la temperatura y humedad durante la germinación, se hayan estrechamente vinculadas, al régimen climatérico del més en que se efectúa la siembra, "prima facie," podemos referir la variabilidad de la infección, como variable dependiente de la época de siembra.

En ese sentido, en otro trabajo (34) y aprovechando las cifras de estos ensayos, llegamos a la conclusion:

CUADRO 4.—*Con la lista clasificada de las variedades y porcentajes de infección, en el lote No. 1, de las siembras de Abril 30 de 1928*

Variedad	Naturaleza	Clasificacion	Total espigas	Espigas "cariadas"	Porcentajes
Florence	L. Pura H.	B.SMD.P.	228	18	7.8
"	"	"	345	25	7.2
"	"	"	223	11	4.9
Lin Calel	L. Pura	C.D.I.	316	298	94.3
Marquis	L. Pura H.	"[a]	354	217	61.3
Ruso Pelon	Sel. Masal	"	450	430	95.5
"	"	"	433	389	89.8
Hibrido de Kalt	L. Pura H.	C.SMD.P.	183	93	50.8
"	"	"	170	76	44.8
Kansas	Sel. Masal	C.D.I.	446	105	23.5
"	"	"	380	51	13.4
Ruso Aristado	"	"	413	403	97.5
"	"	"	337	326	96.8
Era	L. Pura H.	C.SMD.I.P.	242	125	51.6
"	"	"	248	117	47.1
Principe de Gales	"	"	242	134	55.3
"	"	"	173	101	58.4
Maravilla	"	"	284	271	95.4
"	"	"	255	233	91.3
Williamson	L. Pura	C.D.I.	481	381	79.2
"	"	"	377	262	69.4
Pelon Colorado	Sel. Masal	C.D.I.P.	417	354	84.8

[a] El Marquis es considerado en el Canada y EE.UU., un trigo de Primavera. Como en nuestra región, se comporta como trigo de habito invernal, lo hemos clasificado en esa categoria.

que el maximún de condiciones favorables a la infección, parece registrarse en las siembras otoñales de los trigos de invierno—en Abril y Mayo— siendo interesante constatar que Tingey (l. c.), llega a las mismas conclusiones en sus investigaciones en Utah.

Analizando minuciosamente el problema, se vé que los factores que mas influencian la infeción embrionaria son: la temperatura y la humedad. Estudiando estos puntos en la comunicación antes citada, llegamos a las siguientes conclusiones:

1) que las infecciones menores se registran cuando el trigo germina a temperaturas muy bajas (6 a 7 grados C.) regimen termométrico que en la región se tiene en los meses de Junio y Julio;
2) que las mayores infecciones se verifican, cuando el trigo germina en un suelo que se va desecando progresivamente, por faltar el aporte de nuevas lluvias.

CUADRO 4.—(*Continuación*)

Variedad	Naturaleza	Clasificacion	Total espigas	Espigas "cariadas"	Porcentajes
Pelon Colorado	Sel. Masal	"	271	184	67.9
"	"	C.D.I.P.	271	184	67.9
K–08–26	L. Pura	C.D.I.	340	174	51.2
"	"	"	220	108	49.0
K–02–26	"	"	356	105	29.5
"	"	"	311	70	22.6
K–016–26	"	"	423	53	12.5
"	"	"	417	22	5.3
K–012–26	"	"	383	14	3.6
"	"	"	298	5	1.7
K–09–26	"	"	439	45	10.2
"	"	"	329	38	11.5
K–04–26	"	"	361	20	5.5
K–03–26	"	"	396	12	3.0
K–010–26	"	"	416	59	14.2
B x R–C	L. Pura H.	C.SMD.IP.	382	228	59.7
Alaska	Sel. Masal	B.B.P.	99	56	56.5
Pagador	L. Pura H.	C.SMD.IP.	161	76	47.2
Kota	Sel. Masal	C.SMD.I.	170	155	91.1
K–01–28	L. Pura	C.D.I.	355	4	1.1
Kanred	"	"	322	106	32.9

CUADRO 5.—*Con la lista clasificada de las variedades y porcentajes de infección en el lote No. 2, de las siembras de Abril 30 de 1928*

Variedad	Naturaleza	Clasificacion	Total espigas	Espigas "cariadas"	Porcentajes
Florence	L. Pura H.	B.SMD.P.	125	17	13.6
"	"	"	114	7	6.1
"	"	"	138	5	3.6
Tuzela	Sel. Masal	C.SMD.IP.	109	100	91.8
"	"	"	127	118	93.0
Székács 1055	L. Pura H.	C.D.I.	116	5	4.3
(B x R–C) x Kanred Sel. 2	"	"	121	54	44.7
" " 3	"	"	199	109	54.7
" " 4	"	"	194	135	69.5
" " 5	"	"	139	120	86.9
" " 10	"	"	187	101	54.0
" " 15	"	"	194	171	88.1
" " 20	"	"	173	131	75.7
" " 21	"	"	128	84	65.6
" " 22	"	"	112	56	50.0
Székács 266	"	"	100	11	11.0
" 304	"	"	104	9	8.6
" 319	"	"	137	116	84.6

Asi tenemos p. e., que el trigo Florence sembrado en Abril, recibiendo durante la germinación, 6 mm. de agua, dió una infección de 7.2 por ciento como promedio de 6 repeticiones y sembrado en Mayo, sin lluvias durante la germinación, dió una infección de 17.5 por ciento como promedio de 3 repeticiones (ver cuadros 4, 5 y 6).

CUADRO 6.—*Con la lista clasificada de las variedades y porcentajes de infección en el lote No. 1, de las siembras de Mayo 5 de 1928*

Variedad	Naturaleza	Clasificacion	Total espigas	Espigas "cariadas"	Porcentajes
Florence	L. Pura H.	B.SMD.P	285	61	21.5
"	"	"	261	45	17.3
"	"	"	379	52	13.7
"117" S 1	"	C.SMD.IP	180	100	55.5
"117" S 2	"	"	172	127	73.8
"117" S 5	"	"	177	85	48.1
"117" S 7	"	"	106	65	61.4
"117" S 8	"	"	185	62	33.5
Fuliginoso	Sel. Masal	C.SMD.P	79	10	12.7
Belosiornaia	"	B.SMD.IP.	315	276	87.6
Sary Maghis	"	B.SMD.IP.	159	137	86.1
Ulka	"	C.D.I.	283	157	55.4
Tchersnouska	"	B.D.P.	72	17	23.7
Tchersnoostaia	"	"	132	4	3.3
Saratov 41082	"	C.D.IP.	123	93	75.6
K–0279–26	L. Pura	C.D.I.	260	103	39.6
K–0375–IV–27	"	"	451	143	31.7
K–0375–V–27	"	"	380	69	18.1
K–0375–I–27	"	"	447	180	40.3
K–0375–II–27	"	"	283	98	34.6
K–0375–VI–27	"	"	282	118	41.9
K–042–I–27	"	"	311	104	33.5
K–042–II–27	"	"	460	157	34.2
K–042–V–27	"	"	357	166	46.5
K–04–5V–27	"	"	614	194	31.5
K–04–II–27	"	"	354	187	52.8
K–04–VII–27	"	"	338	169	50.0
K–04–III–27	"	"	321	223	69.5
K–04–I–27	"	"	396	229	57.9
K–04–V–27	"	"	367	211	57.5
K–04–VI–27	"	"	367	250	68.1
K–04–26	"	"	491	234	47.7
K–040–II–27	"	"	375	107	28.6
K–040–I–27	"	"	437	77	17.6
K–060–I–27	"	"	452	116	25.6
K–038–26	"	"	426	344	80.2
Kansas 5	"	"	292	34	11.7
" 4	"	"	343	82	24.0
Ballod 5	"	C.B.IP.	280	261	93.3
" 3	"	"	338	311	92.1
K–02–28	"	C.D.I.	305	71	23.3
Tuzela	Sel. Masal	C.SMD.IP.	280	274	97.7
103/16–B3 DG.	L. Pura	"	201	137	68.2
313 x B77 D.G.	"	"	196	177	90.4
X 51 D.G.	"	"	46	45	97.9
III a 2620 D.G.	"	C.SMD.P.	97	92	94.9
XIII a i D.G.	"	"	—	—	—

CUADRO 7.—*Con la lista clasificada de las variedades y porcentajes de infección en las siembras del lote No. 1, de Julio 17 de 1928*

Variedad	Naturaleza	Clasificacion	Total espigas	Espigas "cariadas"	Porcentajes
Barletta Campeon	Sel. Masal	C.SMD.P.	433	367	84.7
Red Bobs	L. Pura H.	"	358	237	66.3
Universal I	L. Pura	"	454	324	71.3
Record Sel. 1928	L. Pura H.	"	423	343	81.2
"38" M.A. Back. Dev.	"	"	182	78	43.0
"110" M.A. Back. Dev.	"	"	302	213	70.5
IV c 3 (17) O Klein	"	"	202	56	27.8
XIII t 1 Klein	"	"	375	63	16.8
H 26 h Klein	"	"	397	85	21.5
H 51 Klein	"	"	282	107	38.0
IV c 390½ Klein	"	"	238	104	43.7
H 28 d Klein	"	"	455	167	36.8
H 52 Klein	"	"	437	46	10.6
III a 123 IFLE	"	"	365	313	85.7
III a 21 (m III, IV) IFLE	"	"	352	281	79.9
IV c (1002, 1006, 1007) IFLE	"	"	235	94	40.0
1149 IFLE	"	"	229	109	47.6
III a 23 (m II) IFLE	"	"	399	329	82.5
III a 23 (m III)		"	363	288	79.4
IV c 100 IFLE	"	"	285	49	17.2
III a 12 IFLE	"	"	376	337	89.7
A c d 3 IFLE	"	B.D.P.	415	38	9.2
III a 23 (m y) IFLE	"	C.SMD.P.	358	331	92.5
IV c 1001, 1004 IFLE	"	"	79	41	51.9
III a 21 (m II) IFLE	"	"	266	222	83.4
IV c 1003111 IFLE	"	"	113	38	33.7
45 b IFLE	"	B.D.P.	211	2	0.95
IV y IFLE	L. Pura	"	209	107	51.4
III a 2620 IFLE	L. Pura H.	C.SMD.P.	297	273	91.9
313 x B77 $\frac{71}{25}$ B	"	"	335	268	80.3
313 x B77 $\frac{61}{25}$ G	"	"	358	271	75.7
XIII e i D.G.	"	"	247	145	58.7
XIII a i D.G.	"	"	143	118	82.6
313 x Bless 62 A D.G.	"	"	423	316	74.8
X 51 D.G.	"	"	252	180	71.5
Record 1925	"	"	329	283	86.0
Chileno	Sel. Masal	B.D.P.	113	24	21.3
Chargarod	"	"	134	17	12.7

CUADRO 8.—*Con la lista clasificada de las variedades y porcentajes de infección, en las siembras del lote No. 2, de Julio 17 de 1928*

Variedad			Naturaleza	Clasificacion	Total espigas	Espigas "cariadas"	Porcentajes
Kanred × Universal II	148	D.G.	L. Pura H.	C.SMD.IP	406	38	9.35
" "	188	"	"	"	501	412	82.2
" "	166	"	"	"	507	76	14.9
" "	134	"	"	"	580	98	16.9
" "	143	"	"	"	384	82	21.4
" "	133	"	"	"	526	147	28.0
" "	130	"	"	"	740	310	41.9
" "	137	"	"	"	665	186	27.9
Kanred 110 F. Pico D.G.			L. Pura	"	338	57	16.9
89/26–85 D.G.		"	"	"	455	372	81.7
Vencedor × Lin Calel	161	"	L. Pura H.	"	630	374	59.4
" "	153	"	"	"	637	263	41.4
" "	157	"	"	"	624	107	17.1
" "	160	"	"	"	708	186	26.3
" "	172	"	"	"	623	512	82.2
" "	179	"	"	"	707	421	59.6
" "	184	"	"	"	738	576	78.0
Vencedor × Kanred	185	"	"	"	737	337	45.7
" "	185/A	D.G.	"	"	618	30	4.9
" "	203	D.G.	"	"	779	167	21.4
" "	194/A	D.G.	"	"	786	351	44.7
" "	198	D.G.	"	"	596	144	24.1
" "	196	"	"	"	658	337	51.3
" "	187	"	"	"	585	214	36.5
" "	194	"	"	"	695	413	59.4
80 C 17 158 Hib. Natural.	D.G.		"	"	746	128	17.2
80 C 10–3–172	"	"	"	"	559	419	75.0
183 C 146/25 Kansas	"		L. Pura	"	667	1	0.15
75/26–86 Kansas	"		"	"	727	2	0.27
170–147/25 Ruso	"		"	"	430	74	17.3

Abreviaturas:

C.D.I.	colorado, duro de Invierno.
C.D.P.	" " Primavera.
C.SMD.I.	" semidura de Invierno.
C.SMD.P.	" " Primavera.
C.SMD.IP.	" " Invierno y Primavera.
B.SMD.P.	blanco, semiduro de Primavera.
B.B.P.	" blando "
L. Pura	linea pura de "popblación."
L. Pura H.	" " "hibrido."
Sel. Masal	Seleccion Masal.
IFLE	Instituto Fitoténico de La Estanzuela.
D.G.	División de Genética.
M.A.	Ministerio de Agricultura de la Nación.
K.	Kansas.

Un caso notablemente confirmativo de esta conclusión, lo hemos tenido el ultimo año. En efecto, resultó que dado el fracaso de un ensayo de anticriptogámicos, que sembrado en Abril—a pleno campo no llegó a germinar por la sequia extraordinaria que sufrimos en 1929, repetimos éste ensayo en otro lugar, sembrando en Julio, en tierra tambien muy seca, que fué necesario regar continuamente hasta lograr una germinación pareja en todas las parcelas. Cosechados los ensayos oportunamente, nos encontramos con que el Testigo Infectado, solo daba una infección de 8.4 por ciento sobre 395 plantas bajo control.

La variedad usada en estas pruebas, es la Record Klein S. V. 1925, variedad cuya gran susceptibilidad a las infecciones experimentales, tal como nosotros las realizamos, la hemos establecido en repetidas ocasiones. Asi tenemos que el Record Klein, el año 1928, en cultivos comunes—no irrigados—nos dió los siguientes guarismos:

Record S. V.	1928	81.2	por ciento
" "	1925	86.0	" "
" "	"	86.4	" "
Promedio		84.5	" "

Todavia más. Una serie de 8 descendencias de la linea genética, III a o Artigas, el homólogo uruguayo de nuestro Record, nos da los siguientes valores:

Descendencia de III, a.		
83.4	por ciento	
85.7	" "	
79.9	" "	
82.5	" "	(ver cuadro 7)
79.4	" "	
89.7	" "	
92.5	" "	
91.9	" "	
Pr. 85.6	" "	

De manera que no cabe dudar de la gran susceptibilidad fisiológica del Record Klein, a la caries.

Y entonces como interpretar su comportamiento en 1929, que lo incluiria entre las variedades fisiologicamente muy resistentes, sino tuviéramos los antecedentes que citamos?

Como la casi totalidad de las condiciones experimentales, han permanecido constantes en los ensayos de 1928 y 1929, es indudable entonces, la influencia decisiva del agua de riego, que le hemos prodigado durante la germinación, la que actuando como lluvias de poco milimetraje pero casi

diarias, han creado el ambiente desfavorable para la infección, que ya otros autores le reconocen, a las tierras saturadas de agua por lluvias repetidas: Boerger (3), Woolman y Humphrey (54).

(II) *Comportamiento según los caracteres filogenéticos de los grupos o subespecies.* En el cuadro 2, de este trabajo, exponemos la lista de las subespecies que hemos ensayado, clasificadas según sus caracteres genéticos y morfológicos, conforme a la clasificacion de Vavilov.

En el cuadro 9 que acompañamos, hemos agrupado ciertas variedades de *Triticum vulgare* y todas las demás de las otras subespecies, a los efectos de facilitar una visión rápida del conjunto.

El cotejo de los diversos promedios, permite llegar a las siguientes conclusiones:

1) que de un modo general, los trigos a 14 pares de cromosomas, presentan mayor resistencia media que los trigos a 21 pares de cromosomas (con excepción del grupo de los "hard red winter" confirmando las observaciones de Vavilov (51), Percival (38), Tisdale (48) y otros autores.
2) que la subespecie *Triticum vulgare*, presenta la variabilidod mas extraordinaria en lo que respecta al comportamiento de sus variedades a la infección por Tilletia, siendo interesante constatar que Tapke (46) llega al mismo resultado, en sus últimas investigaciones sobre el carbón volador (*U. tritici*).

Debemos destacar que la primera conclusión, no tiene valor de generalización en nuestros ensayos, pues solamente hemos testado, ocho variedades a 14 pares de cromosomas, las que dán un promedio general de 17.5 por ciento, con valores limites de 0.9 a 56.5 por ciento.

Es probable que trabajando con un gran número de variedades y con diversas colecciones de Tilletias, se encuentre en este grupo tanta variabilidad en la resistencia, como en el grupo de los *Triticum vulgare*.

Pese a que autores tan eminentes como Vavilov, Percival, Sax y Stakman, han creido reconocer en este grupo, una resistencia general a las enfermedades, que vinculaban a su peculiar estructura genética, dia a dia esta conclusión ha ido perdiendo su consistencia, en virtud de las nuevas experiencias realizadas. Limitándonos a lo referente a las Tilletias, ya en el trabajo relatado por Tisdale (l. c.), puede verse que ciertos *T. durum* son susceptibles de infecciones pesadisimas, (hasta 92.7 por ciento en la variedad Marouani C. I. 2235), con la colección de *T. tritici* usada en Davis (California).

Brentzel y Smith (4), en experimentos conducidos en Fargo y Dickinson (North Dakota), encuentran que allí, los *Triticum durum*, son un 100 por ciento mas susceptibles a la *Tilletia tritici* que a la *T. levis*, mientras que los "hard red spring wheats," presentan la reacción opuesta.

CUADRO 9.—*Mostrando la susceptibilidad a la caries, según los caracteres filogenéticos de las subespecies y su hábito de vida.*

Triticum vulgare

Variedades de Invierno		Variedades de Primavera	
Lin Calel	94.3 por ciento	Barletta	84.7 por ciento
Kanred	32.9 " "	Universal I	71.3 " "
Ruso mútico	95.5 " "	Record 1928	81.2 " "
Ruso aristado	97.1 " "	"38" M.A.	43.0 " "
Pelón colorado	76.3 " "	"110" M.A.	70.5 " "
Tuzela	92.4 " "	Promedio	70.1 por ciento
Kansas	18.4 " "		
Williamson	74.3 " "		
Promedio	72.6 por ciento		
Excluyendo Kanred y Kansas, el promedio asciende a	83.3 por ciento		

Nuevas variedades de Invierno		Nuevas variedades de Primavera	
K–016–26, Cheg	8.9 por ciento	XIII t 1 Klein	16.8 por ciento
K–012–26, "	2.6 " "	H 26 h "	21.5 " "
K– 09–26, "	10.8 " "	IV c 390½ "	43.7 " "
K– 03–26, "	3.0 " "	H 28 d "	36.8 " "
K– 01–28, "	1.1 " "	H 52 "	10.6 " "
Székács 1055	4.3 " "	H 51 "	38.0 " "
" 266	11.0 " "	Promedio	27.9 por ciento
" 304	8.6 " "		
146–183– c D.G.	0.15 " "		
75/26–86 D.G.	0.27 " "		
Promedio	5.07 por ciento		

Triticum compactum

Ballod 5, Cheg	93.3 por ciento
" 3, "	92.1 " "
Promedio	92.7 por ciento

Triticum durum Desf.

Tchersnouska	23.7 por ciento
Tchernoostaia	3.0 " "
A c d 3 IFLE	9.2 " "
45 b "	0.9 " "
Chileno	21.3 " "
Chargarod	12.7 " "

Triticum persicum Vav.

Fuliginosum	12.7 por ciento

Triticum turgidum L.

Alaska	56.5 por ciento

Reichert (l. c), encuentra que en Palestina, los *Triticum durum* son normalmente más atacados por la Tilletia de esa region que los *Triticum vulgare,* lo que hace presumir la existencia de formas fisiológicas especialmente virulentas sobre los *T. durum.*

Recientemente Holton (l. c.), ha demostrado que una colección de *Tilletia tritici* de Devils Lake (North Dakota), era extremandamente virulenta sobre los *Triticum durum,* comunmente cultivados en esa región, mientras que ciertas variedades a 21 pares de cromosomas como el Marquis, Marquillo, y Hope, permanecian practicamente inmunes. Indudablemente lo que ha complicado notablemente estas investigaciones, ha sido la existencia de formas fisiológicas especializadas en ambas Tilletias.

Probablemente en un futuro proximo, nuevas investigaciones debilitarán cada véz más las conclusiones de Vavilov (l. 51), sobre interrelaciones, de la inmunidad con la naturaleza filogenética de las subespecies, a las que no obstante debe reconocerse el servicio inapreciable que han prestado a la investigación, como "hipótesis de trabajo."

(III) *Comportamiento de los Triticum vulgare.* En primer término, lo que llama la atención, es la variabilidad extraordinaria, de la resistencia de sus variedades y "pequeñas especies" (lineas puras en el concepto de Johannsen).

Se tiene toda la gama, desde la enorme susceptibilidad revelada por un Ruso aristado, Tuzela o Lin Calel, con porcentajes de 100 por ciento de infección "en plantas" y 95 a 98 por ciento "en espigas," a la resistencia rayana en la inmunidad, de las nuevas lineas genéticas 146–183 c D. G.; K–01–28 Cheg; etc., con valores hasta de 0.15 por ciento.

Por otra parte interesa constatar, que el mayor número de "formas nuevas muy resistentes" se encontraron en un sub-grupo de trigos aristados, a espiga laxa y blanca, de hábito invernal y especialmente adaptados a vivir en regiones frias y secas, (*Triticum vulgare* v. *erythrospermum*).

Este subgrupo esta constituido por trigos de invierno de Hungria (Székács Winter Weizen), lineas puras de Kansas de nuestra experimentación y lineas puras de Kansas de la División de Genética Vegetal.

Es conveniente hacer notar que dichas lineas puras de Kansas, proceden de un material ensayado por Backhouse (2), en 1916, que se trataba sin duda, de algunas de las selecciones que según Jardine, (27) fueron aisladas por H. F. Roberts, del Crimean C. I. 1435, que dió como resultado la creación del Kanred (ex- P–762), (6).

Dicho Crimean C. I. 1435, es un trigo colorado de Invierno y según Clark (6), fué importado a Estados Unidos, en 1900, procedente de Ambracievka, Territorio del Don (Rusia). (De un punto muy próximo a Ambracievka seria oriundo el Turkey, variedad muy difundida en Estados

Unidos, que en las pruebas de Gaines (17), dió solo 1.8 por ciento de infección por *Tilletia tritici*).

Es interesante referirnos al común y primitivo origen geográfico del Kanred y nuestras lineas puras, por cuanto además de su resistencia al frio y a la seca, una común resistencia a las enfermedades las identifica.

Ya nos hemos referido a la inmunidad del Kanred con respecto a 11 formas fisiológicas de *Puccinia graminis tritici* Eriks. and Henn. (32), y agregaremos que Kiesselbach y Peltier (29), estudiando 578 selecciones de Crimean C. I. 1435, encontraron un grupo de selecciones mas resistentes que el Kanred o inmunes a nuevas formas fisiológicas a las que el Kanred era susceptible.

Ya hemos visto en el cuadro 9, como se comportan algunas de nuestras lineas muy resistentes, y la enorme diferenciación fisiológica que revelan al cotejarlas con otras estirpes genéticas regionales, tales como el Lin Calel M. A., o el Williamson.

No se crea que todas las lineas de Kansas, son tan resistentes como las mencionadas. Dentro de una resistencia próxima a la del Kanred (30 a 40 por ciento), se agrupa la mayoria de las lineas restantes, presentándose como una excepción la linea K–038–26, Cheg con una infección de 80.2 por ciento.

Debe llamarnos la atención que casi todas estas variedades muy resistentes, pertenezcan a un mismo tipo biológico (*Triticum vulgare* v. *erythrospermum*), y que muchas de ellas tengan la misma cuna geográfica. (No debe olvidarse sin embargo que tipos muy resistentes, tambien los hay en *T. vulgare* v. *albidum* ej. Florence; en *T. vulgare* v. *ferrugineum* ej. K–09–26 Cheg.—Una linea de *T. vulgare* v. *milturum*, la M–0274 de la Estacion Experimental de Odessa, tambien ha sido señalada como inmune por Talanoff (45). Una estirpe fisiologicamente inmune puede citarse para *T. compactum* v. *humboldtii*, merced al nuevo hibrido de Gaines, el Albit C. I. 8275 (Hibrido 128 x White Odessa), (7 y 18).

Anteriormente hemos afirmado que en las regiones frias y secas, como el S. E. de la Pampa, se tendrian las condiciones mas favorables para la producción de fuertes infecciones, confirmando nuestra conclusión, observaciones analogas de Tingey (l. c.) en Nebraska, Dickson (l. c.) en Kansas, y Tisdale et al. (l. c.), en los estados norte americanos de la costa del Pacifico.

Es indudable que la Crimea rusa tiene grandes similitudes agrológicas y climatéricas con el Oeste de Kansas y La Pampa—buena prueba de ello, es que sus tipos biológicos se adaptan perfectamente a estas ultimas regiones —y que las condiciones del ambiente son muy favorables a la infección por caries.

Como entre sus tipos indígenas de trigo, pueden aislarse estirpes altamente resistentes, la lógica nos llevaria a enunciar la siguiente conclusión: que cuanto más favorables a la infección son las condiciones climatéricas y agrológicas de una región, mayores son las probabilidades de encontrar entre las viejas razas autóctonas, estirpes altamente resistentes.

Esta conclusión seria concorde con las ideas de Nilsson-Ehle (37), sobre la adaptación.

(IV) *Comportamiento del T. persicum.* Por ser una subespecie poco conocida nos detendremos brevemente, consignando los datos mas recientes y autorizados sobre la misma.

Es una nueva especie establecida hace pocos años por Vavilov (51). Zhukowsky (55), y Atabekova (1), han clasificado numerosas variedades de esta "nov. sp.," bien diferenciadas por los caracteres de su espiga, caracteres vegetativos y biológicos.

Percival (l. c.), la habia considerado una variedad de *Triticum dicoccum* y anteriormente habia sido descripta como *T. vulgare* v. *fuliginosum.* Morfologicamente es muy semejante al *T. vulgare,* pero por sus caracteres fisiológicos y número de cromosomas es un *T. durum.*

Fundado en estas caracteristicas, en su cuna geográfica y centro de diversidad (9), Vavilov (52), sostiene que se trata de un hibrido inter-especifico de *T. vulgare* x *T. durum* y representaria una forma de transición.

Inmune al "Oidium" (*Erysiphe graminis*), Vavilov (50) establece esta caracteristica como una caso único entre otras 580 variedades por él cotejadas.

Susceptible a la *Puccinia triticina,* ha sido cruzada por Vavilov (50) en Reading (Inglaterra), con una variedad de *T. vulgare* inmune a dicha "roya," obteniendo en la F_1 o primera generación, un hibrido inmune a ambos parásitos, probando la dominancia de la inmunidad como caracter hereditario.

Vavilov (51), lo encuentra muy susceptible a la caries en pruebas que realiza al efecto, pero agrega que un proceso de incompatibilidad puede observarse, ya que los granos "cariados," son pequeños y abortivos.

En nuestras pruebas se reveló como muy resistente a la *Tilletia levis,* dando solo 12.7 por ciento de infección.

Según el mismo autor, es facilmente cruzado con los *T. durum,* con los que daria hibridos perfectamente fértiles. Segun Percival (38) con los *T. vulgare,* daria hibridos "casi estériles" en la F_1.

Nuestras observaciones sobre hibridos inter-especificos (33), nos dán con respecto al *T. persicum* v. *fuliginosum,* los siguientes resultados:

en el hibrido *T. vulgare* v. *ferrugineum* x *T. persicum* v. *fuliginosum,*

sobre 16 flores fecundadas artificialmente, obtenemos 12 granos bastante "chuzos," lo que revelaba ya, un proceso de incompatibilidad genética.

de los 12 granos nacieron 9 plantas que se desarrollaron bien, siendo perfectamente visible en todas, su naturaleza hibrida, por la dominancia de caracteres tales como, Pubescencia de las Glumas, Hollin o "fuligo" de las espigas, Bordes colorados de las Glumas, etc., todos caracteres distintivos del ascendiente paterno;

esta F_1 presenta basteantes pústulas de *P. triticina, P. glumarum* Eriks. and Henn. y *P. graminis tritici,* mientras que el *T. persicum* se manifestó casi inmune a la *P. graminis tritici* y muy poco atacado por las *P. triticina* (Schm.) Eriks. & Henn.; y *P. glumarum;*

como el ascendiente susceptible—el *T. vulgare* v. *ferrugineum*—se manifestó a la véz extraordinariamente atacado por *P. glumarum* y *P. graminis tritici,* tendriamos una nueva prueba confirmativa de la naturaleza recesiva del caracter "resistencia a las royas" (32);

finalmente examinando las espigas hemos constatado la casi total autoesterilidad, del hibrido en F_1;

en una planta, sobre 221 flores solo fecundaron y formaron granos, 11;

en una segunda sobre 402 flores, se obtuvieron solamente 24 granos; es decir un 95 por ciento y un 94 por ciento respectivamente de "autoesterilidad";

los granos son extremadamente "chuzos" y ahora falta saber en que proporción seran "autovitales."

(V) *Regularidades observadas en la resistencia a diversas enfermedales.* Es interesante hacer notas que Tapke en un valioso trabojo sobre el carbón volador (*Ustilago tritici*), llega a conclusiones semejantes a las que hemos enunciado.

Dice este autor en su "Occurrence of loose smut on wheat" (46):

Pentad, el unico *Triticum durum,* incluido en los ensayos, fue altamente resistente (0.20 por ciento). Los tres trigos "club" cotejados (*T. compactum*), se mostraron fuertemente susceptibles, alcanzando hasta un 97 por ciento de espigas atacadas en el Little Club C. I. 4066. En los trigos comunes (*T. vulgare*), la escala de resistencia vá desde la mas elevada susceptibilidad, a la inmunidad absoluta. Las variedades altamente resistentes son relativamente pocas, pero una o mas se encontraron en cada uno de los cuatro grupos comerciales, excepción hecha de los trigos blancos (*T. vulgare* v. *albidum; T. vulgare* v. *graecum,* etc.).

en trigos "poblaciones" tales como el Fulcaster, Gipsy, Harvest

en trigos "poblaciones" tales como el Fulcaster, Gipsy, Harvest

Queen y Red May.

Las lineas puras de Hussar (Red Hussar C. I. 4843) y Ridit (Smutproof C. I. 6703), son altamente resistentes e immune respectivamente al "carbón volador."

Estas mismas selecciones han demostrado ser inmunes a la caries.

Fué evidente la existencia de formas fisiológicas especializadas, en *U. tritici.*

No se encontró correlación entre los valores "iones-hidrógeno" de los jugos (acidez) y la capacidad de resistencia de los huéspedes a la infección.

Y es interesante, repetimos, por cuanto las similitudes observadas en el comportamiento a diversas enfermedades, tales como Puccinias, Tilletias, Ustilago, etc., cuando se consideran diversos grupos filogenéticos, permiten sospechar la existencia de condiciones generales que regularian las infecciones, tales como la Naturaleza Genetica De Las Subespecies, problema especialmente estudiado por Vavilov y que fundamenta una de sus leyes sobre la "Distribucion de la Inmunidad en las Plantas" (51). O la elevada Actividad Osmotica Endocelular, argumento sostenido entusiastamente por Draghetti (13), quien vincula la elevada resistencia de los *T. durum; T. vulgare* v. *esythrospermum,* etc., a que la subespecie o variedad botánica considerada, presentaria comunmente el Máximo Número y Las Máximas Manifestaciones De Los Caracteres Hipertonizantes De Los Jugos. Hoy, ya no se acepta, que la resistencia a las enfermedades deba referirse a la cantidad de ácidos orgánicos del contenido celular, hipótesis sostenida por Comes, Lo Priore y Kirchner y otros autores, Negada esta teoria por los trabajos de Vavilov, es nuevamente desautorizada por las observaciones recientes de Hurd-Karrer y Tapke (24, 25 y 46).

Es indudable que ya no puede aceptarse ninguna hipótesis simplista sobre la naturaleza de la resistencia a las enfermedades y que limitando a sus verdaderas proporciones, los casos de Resistencia Morfológica, reconocidos por Hursh (26) y de Resistencia Funcional reconocidos por Hart (21), debe admitirse la compleja naturaleza de la Resistencia Fisiológica, la que al decir de Vavilov, seria la resultante de muy complicadas interrelaciones fisiológicas entre el parásito y el protoplasma de las células huéspedes.

(VI) *Irregularidades que se observan cuando se comparan los resultados obtenidos en diversos lugares.* Por lo general, cuando se comparan los resultados de ensayos de infección, realizados en diversas situaciones geográficas, se observa que los mismos difieren casi completamente.

Estas diferencias lejos de ser anormales, responden a causas naturales, cuya verdadera naturaleza conviene siempre establecer. Asi, nuestros resultados, obtenidos en Guatraché, en el S. E. de La Pampa, difieren mar-

cadamente de los de Brunini, obtenidos en Barrow, en el S. E. de Buenos Aires.

Concretando lo que hemos expuesto en otro lugar (34), la no coincidencia de los resultados entre dos experimentaciones, tales como la de Guatraché y Barrow, puede imputarse a algunas de las siguientes causas:

1) Influencia del ambiente (temperatura, humedad y suelo).
2) Influencia de la época de siembra.
3) Naturaleza especifica del parásito; posible existencia de formas fisiológicas especializadas, (sobre este particular conviene recordar que han sido reconocidas recientemente, numerosas formas fisiológicas especializadas en ambas Tilletias, por Faris (14), Rodenhiser y Stakman (41), Reed (39), Rodenhiser (42), Gaines y Romer (19), Gaines y Smith (20), Reichert (40), Holton (23); etc. Reed, solamente, en 42 colecciones testadas sobre 18 huéspedes diferenciales, prueba que hay por lo menos 4 f. f. en *Tilletia levis* y 6 f. f. en *T. tritici,* en sus colecciones).
4) Errores en la identificación de las variedades.
5) Empleo de distintas lineas genéticas (de una variedad común), con distinta susceptibilidad.
6) Naturaleza de la infección experimental. Métodos de investigación y exposición de los resultados.
7) Causas accidentales no establecidas o no sospechadas por el investigador.

SUMMARY

Object and Methods.—Tilletia levis and *T. tritici* have been found in different sections of the Argentine wheat area, but the geographic distribution, comparative virulence, and forms of each are not yet exactly known.

Particularly in the winter-wheat area, which embraces La Pampa and Western and Southern Buenos Aires, bunt annually produces considerable loss.

Although there has been an increasing development of seed-disinfection methods involving use of chemical dusts, such as copper carbonate, Uspulun, Abavit 26, and others, many farmers still employ copper sulphate, which often produces severe losses through seed injury.

In some sections, also, infection occur through bunt spores present in the soil.

The virtual impossibility of an effective control of this disease in regions subject to soil infestation has impelled the Dirección General de Enseñanza y Fomento Agricola del Ministerio de Agricultura de la Nación, to develop for such sections varieties of wheat inmune from *Tilletia,* spp., varieties that are at the same time acceptable agronomically and industrially. This

work will be carried out by the Guatrache Experiment Station. A preliminary study of varietal resistance of wheat to *Tilletia levis* collected in Guatrache was made involving 154 varieties belonging to 5 subspecies. Of the 154 varieties 80 were winter wheats and 74, spring or midseason varieties, comprising most of the wheats cultivated in Argentine, new pure lines and hybrid selections still in the nursery tests, and some well-known foreign varieties.

The seed was heavily inoculated just before seeding with fresh spores of *Tilletia levis* obtained the previous year from the variety Tuzela. The seed was sown on three consecutive dates, April 30, May 5, and July 17; the temperature and humidity conditions were carefully noted during the period of germination following each date. The results are given in percentages of bunted heads, being based on the examination of 59,194 heads of this crop. They refer only to the experiments of 1928. The same varietal trials repeated in 1929 were destroyed by an unusual drought that killed all the crops in this year.

The desire to prevent any delay in the presentation of the results of these experiments, the first ever obtained on a large scale in Argentine, justifies their presentation at this time.

Conclusion: 1. The most favorable conditions for infection of fall-sown winter varieties by Tilletia obtained in April and May.

2. The widest spread of infection was noticed where wheat germinated in a soil gradually drying out from lack of rain.

3. Generally, with the exception of varieties belonging to the hard red-winter group wheats of 14 pairs of chromosomes offer greater resistance to bunt than do those of 21 pairs.

The writer, however, believes after treating a larger number of varieties of 14 pairs of chromosomes with different collections of Tilletia, almost as great a variation in resistance should be encountered as that observed in the *T. vulgare* group.

4. The subspecies *T. vulgare* presents the most extraordinary variability in respect to the behavior of its varieties to infection by Tilletia, ranging from almost total susceptibility to almost complete immunity. It is of interest to note that most of the new very resistant strains are found in a subgroup of winter-habit wheats, with bearded, lax, white heads, and hard red kernels that are specially adapted to cold, dry regions (*T. vulgare* v. *erythrospermum*).

5. Very susceptible to highly resistant strains have been found in a local variety known as Kansas, which is probably the same as Crimean C. I. 1435 of the United States Department of Agriculture.

Three years of yield experiments with these new strains indicate a possibility of their becoming valuable commercial varieties.

6. Certain strains of winter wheats from Hungary and the variety Florence from Australia were shown to be highly resistant.

7. All the highly resistant strains have been used to cross with other highly productive Argentine varieties of good milling and baking qualities.

ESTACION EXPERIMENTAL DE GUATRACHE (PAMPA CENTRAL),
MINISTERIO DE AGRICULTURA DE LA NACION,
REPUBLICA ARGENTINA.

LITERATURA CITADA

1. ATABEKOVA, A. Materials for a monographic study of a new species of cultivated wheat T. persicum Vav. Bul. Appl. Bot. and Plant Breeding **15**: 161–198. Russian, English Summary. 1925.
2. BACKHOUSE, W. O. Mejoramiento de trigos. Pub. del Min. de Agr. de la Nación. No. 73. Argentina. 1917.
3. BOERGER, A. Observaciones sobre Agricultura; quince años de trabajos fitotécnicos en el Uruguay. 580 pp. Montevideo. 1928.
4. BRENTZEL, W. E., and R. W. SMITH. Varietal resistance of spring wheats to bunt. North Dakota Agr. Exp. Sta. Bul. 231. 1929.
5. BRUNINI, V. C. Ensayos sobre la "caries" del trigo (Tilletia). Bol. de la Ch. Exp. de la Previsión. Tomo I. No. 1. Argentina. 1930.
6. CLARK, J. A., J. H. MARTIN, and C. R. BALL. Classification of American wheat varieties. U. S. Dept. Agr. Bul. 1074: 238 pp. 1922.
7. ————, J. H. PARKER, and L. R. WALDRON. Registration of improved wheat varieties, II. Jour. Amer. Soc. Agron. **19**: 1037–1041. 1927.
8. DARNELL-SMITH, G. P. [Observations upon the disease of wheat known as "bunt"]. Rpt. Govt. Bur. Microbiol., N. S. Wales (1909), pp. 64–69. 1910.
9. DEKAPRELEVICH, L. The geographical center of the culture of Persian wheat Triticum persicum Vav. Bul. Appl. Bot. and Plant Breeding **15**: 199–202. Russian. 1925.
10. DELACROIX, G., and A. MAUBLANC. Enfermedades parasitarias de las plantas cultivadas. 1–457. P. Salvat. Barcelona. 1919.
11. DICKSON, J. G. Making weather to order for the study of grain diseases. Wis. Agr. Exp. Sta. Bul. 379. 1925.
12. DONKIN, J. E. Bunt-resistant wheat. Jour. S. Africa Dept. Agr. **3**: 561–563. 1921.
13. DRAGHETTI, A. I caratteri osmotici quale causa della resistenza dei frumenti alla ruggini. 1927. Riv. Patol. Veg. **18**: 41–64. 1928.
14. FARIS, J. A. Factors influencing the infection of wheat by Tilletia tritici and Tilletia laevis. Mycologia **16**: 259–282. 1924.
15. FARRER, W. Results of the Lambrigg bunt experiments of 1900. Agr. Gaz. N. S. Wales **12**: 419–430. 1901.
16. ————. Report of the wheat experimentalist. Agr. Gaz. N. S. Wales **15**: 1047–1050. 1904.
17. GAINES, E. F. Comparative smut resistance of Washington wheats. Jour. Amer. Soc. Agron. **10**: 218–222. 1918.
18. ————, E. G. SCHAFER, and O. E. BARBEE. Wheat varieties in Washington. Wash. Agr. Exp. Sta. Bul. 207. 1926.

19. ————————. New physiologic forms of Tilletia levis and T. tritici. Phytopath. 18: 579–588. 1928.
20. ————————, and W. K. SMITH. Smut resistance in wheat. Ann. Rpt. Wash. Agr. Exp. Sta. 1929.
21. HART, H. Relation of stomatal behavior to stem rust resistance in wheat. Jour. Agr. Res. 39: 929–948. 1929.
22. HECKE, L. Der Einfluss von Sorte und Temperatur auf den Stein-Brand befall. Zeitsch. Landw. Versuchsw. in Oesterr. 12: 49–66. 1909.
23. HOLTON, C. S. A probable explanation of recent epidemics of bunt in durum wheats. Phytopath. 20: 353–357. 1930.
24. HURD-KARRER, A. M. Hydrogen-ion concentration and varietal resistance of wheat to stem rust and other diseases. Jour. Agr. Res. 23: 373–386. 1923.
25. ————————. Acidity and varietal resistance of wheat to Tilletia tritici. Amer. Jour. Bot. 12: 359–371. 1925.
26. HURSH, C. R. Morphological and physiological studies on the resistance of wheat to Puccinia graminis tritici, Erikss. and Henn. Jour. Agr. Res. 27: 381–412. 1924.
27. JARDINE, W. M. A new wheat for Kansas. Jour. Amer. Soc. Agron. 9: 257–266. 1917.
28. KIESSELBACH, T. A., and G. L. PELTIER. The differential reaction of strains within a variety of wheat to physiologic forms of Puccinia graminis tritici. Nebr. Agr. Exp. Sta. Res. Bul. 39. 1926.
29. KIRCHNER, O. Neue Beobachtungen über die Empfänglichkeit verschiedener Weizensorten für die Steinbrandkrankheit Fühl. Landw. Zeit. 57: 161–170. 1908.
30. MARCHAL, E. Eléments de pathologie végétale appliquée à l'agronomie e à la silviculture. Gembloux, J. Duculot; [etc.]. 312 pp. 1925.
31. MCALPINE, D. The smuts of Australia, their structure, life history, treatment, and classification. 288 pp. Melbourne. 1910.
32. NIEVES, R. Investigaciones preliminares sobre la herencia de los caracteres en el trigo. Rev. Fac. Agron. Univ. La Plata. 18: 359–368. Argentina. 1929.
33. ————————. Hibridos inter-especificos. Memoria Anual de la Est. Exp. de Guatrache. Argentina. 1929.
34. ————————. Contribución al conocimiento de la "caries" del trigo, (Tilletia spp.). Bol. Min. Agr. Nac. 29: 97–112. Argentina. 1930.
35. ————————. Valor desinfectante, influencia sobre la germinación y acción estimulante, de algunos anticriptogámos, contra la "caries" del trigo. Cuatro años de ensayos comparativos en la Est. Exp. de Guatraché. Argentina. 1930. (En prensa).
36. ————————. Ensayos de infección dosada con Tilletia levis, Kühn. Influencia sobre la utilización de polvos anticriptogámicos. Est. Exp. de Guatraché. Argentina. 1930. (En prensa).
37. NILSSON-EHLE H. Mendélisme et acclimatation. IVe. Conférence Internationale de Génétique. 136–157. Paris. 1913.
38. PERCIVAL, J. The wheat plant: a monograph. 463 pp. Duckworth & Co., London. 1921.
39. REED, G. M. Physiologic races of bunt of wheat. Amer. Jour. Bot. 15: 157–170. 1928.
40. REICHERT, I. Comparative bunt resistance of wheat in Palestine. Agr. Exp. Sta. Inst. Agr. and Nat. Hist., Zionist Organ. Bul. 9. 1928.

41. RODENHISER, H. A., and E. C. STAKMAN. Physiologic specialization in Tilletia levis and Tilletia tritici. Phytopath. 17: 247–253. 1927.
42. ————————. Physiologic specialization in some cereal smuts. Phytopath. 18: 955–1003. 1928.
43. STAKMAN, E. C., E. B. LAMBERT, and H. H. FLOR. Varietal resistance of spring wheats to Tilletia levis. Minn. Studies in Plant Sci., Studies in Biol. Sci. No. 5, pp. 307–317. 1924.
44. STEVENS, F. L., and J. G. HALL. Diseases of economic plants. 507 pp. The MacMillan Co., New York. 1921.
45. TALANOFF, V. V. Spring wheats, its best improved varieties, their productivity and quality. Bul. Appl. Bot. and Plant Breeding. 15. 1925.
46. TAPKE, V. F. Influence of varietal resistance, sap acidity, and certain environmental factors on the occurrence of loose smut in wheat. Jour. Agr. Res. 39: 313–339. 1929.
47. TINGEY, D. C. Smut studies preliminary to wheat breeding for resistance to bunt. Jour. Amer. Soc. Agron. 19: 655–660. 1927.
48. TISDALE, W. H., J. H. MARTIN, F. N. BRIGGS, W. W. MACKIE, H. M. WOOLMAN, D. E. STEPHENS, E. F. GAINES, and F. J. STEVENSON. Relative resistance of wheat to bunt in the Pacific Coast States. U. S. Dept. Agr. Bul. 1299. 1925.
49. TUBEUF, C. VON. Studien über die Brandkrankheiten des Getreides und ihre Bekämpfung. Arb. Biol. Abt. K. Gsndhtsamt., 2: 179–349. 1901.
50. VAVILOV, N. I. Breeding for resistance to rust and mildew in wheat. Jour. Genetics 4. 1915.
51. ————————. Immunity of plants from infectious diseases. Ann. Acad. Agron. Petrovsk (1918) 1–239. 1919.
52. ————————. A contribution to the phylogenesis of wheat and the inter-species hybridization in wheats. Bul. Appl. Bot. and Plant Breeding. Vol. 15: 3–159. 1925.
53. WILLIAMSON, J. Caries y carbón, de las plantas cultivadas. Nuestra Chacra. 3: (No. 14) 9–11. 1928.
54. WOOLMAN, H. M., and H. B. HUMPHREY. Studies in the physiology and control of bunt, or stinking smut, of wheat. U. S. Dept. Agr. Bul. 1239. 1924.
55. ZHUKOVSHY, P. M. "Persian wheat," Triticum persicum var. in Transcaucasia. Bul. Appl. Bot. and Plant Breeding 13: (No. 1) 54–55. 1923.

BORDEAUX MIXTURE AS A FACTOR INCREASING DROUTH INJURY[1]

J. D. Wilson and H. A. Runnels

Ginseng, *Panax quinquefolium* L., is commonly grown in wood lots in Ohio. Those best adapted to the culture of this crop consist of large trees in open stand, their branches just interlacing so that the shade provided is continuous and of a fairly uniform density. All underbrush is removed and the beds are then prepared, much as when lath shelters are used.

Many of the ginseng plantings in Ohio are frequently attacked by Alternaria blight (*Alternaria panax* Whetzel) and, for this reason, must be sprayed. The most common treatment is that involving three or four applications of a 3–3–50 Bordeaux mixture. The timing of the sprays is regulated by the growth stage of the plant, as follows: Just as the majority of the plants are through the ground, after the leaves are fully expanded, shortly before bloom, and, finally, just after the fruits are well formed. During the past four summers the writers have been treating several plots in each of two wood lots near Wooster, Ohio, in an effort to determine some of the most effective spray and dust mixtures for the control of the disease mentioned above.

In 1930 the first application of materials was made on May 15, the second on May 31, and the third on June 25, and the fourth was omitted. At the time of the third application a considerable number of plants in both wood lots were beginning to show a type of ginseng foliage injury with which neither the growers nor the writers were familiar and which was considerably different from that commonly caused by improperly prepared Bordeaux mixture.

The first indication of this injury was a drooping of the individual leaflets. Next, the tissue at the margins of the leaflets suddenly began to collapse, first taking on a darkened, water-soaked appearance, and, later, drying out. The silvery green of the ginseng leaflets faded somewhat but did not disappear, nor did the blades become yellow. The margins of the leaflets finally became wrinkled and crisp. The drying-out progressed from the tip toward the base and from the edges inward much like tipburn in such plants as the potato. The tissue adjacent to the midrib and near the base of the leaflet often remained alive and green for some time after the margins were dead and dry. The plant at this stage appeared much as in figure 1, A, which was photographed on June 25. This may be com-

[1] Published with the approval of the Director of the Ohio Agricultural Experiment Station, Wooster, Ohio.

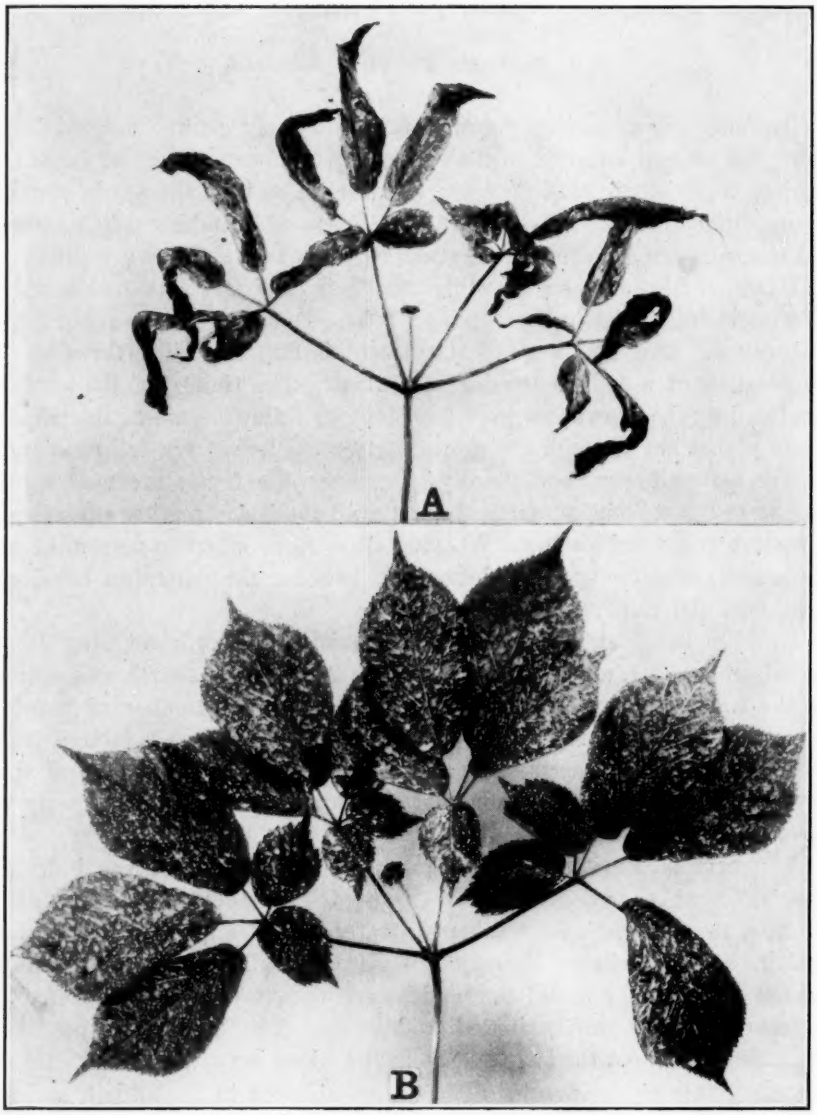

FIG. 1. A. Combination drouth and spray injury on ginseng. Sprayed with Bordeaux mixture. B. Normal ginseng plant sprayed with Bordeaux mixture.

pared with the normal plant of figure 1, B. Finally, the leaflets became tightly curled about the petioles, the latter then collapsing at their point of attachment to the stem. The leaflets remained attached to the petioles in many cases.

The injured-plant areas became progressively larger and new ones appeared as the days passed. By July 25 such a large proportion of the plants in both plantings had died that it was considered useless to make the fourth application of materials to the experimental plots. The majority of the plants failed to bloom properly and many of the young fruits dropped before maturity.

The general appearance of the dying plants and the manner in which the injury areas increased in size and number suggested drouth damage. The fact that many herbaceous plants in fields and wooded areas were beginning to suffer from a lack of soil moisture and the extremely dry aerial environmental conditions made it seem even more likely that the ginseng plants were being injured in the same way. Shade-loving plants, as a group, of which ginseng is a member, are particularly sensitive to conditions of high evaporation, lack of soil moisture, and an excess of light over the normal for their habitat. Burns (3) reported the death of pine seedlings, in exposed situations during a period of drying winds, and the marginal burning of leaves of other shaded plants when suddenly exposed to bright sunlight. Pool (18) noted that many species, normally occurring on forest floors, were either scarce or absent during a dry summer in Nebraska. Observations similar to those of Pool were made in Ohio forests during the summer of 1930. The competition for water finally became so severe that many of the trees began to lose some of their leaves and, by mid-July, many of the beech trees in Ohio had been defoliated.

The rainfall at Wooster from May 1 to July 31, 1930, inclusive, was only 51.4 per cent of the normal. The mean temperature was 2.4° F. above normal. The evaporating power of the air, measured with white, spherical atmometers, was 51.1 per cent higher than the average over the same period for the summers of 1928 and 1929. Drouth conditions during July, the month of greatest injury to vegetation, were especially severe. The rainfall was only 42.1 per cent of the normal and the evaporation total was 77 per cent greater than the average value for the same month in 1928 and 1929. This low rainfall and high evaporation rate resulted in the establishment of semixerophytic conditions under which many of the plant forms accustomed to a more plentiful moisture supply were not able to survive. Many species succumbed wholly or in part and many individual plants of different species lost all or part of their foliage. Thus it is not strange that a tender plant like ginseng should show injury, especially when in competition with deep-rooted trees for soil moisture.

On July 25, at the time it was decided not to put on the fourth spray application, there were still a number of isolated areas in each wood lot in which the plants were in good condition. Some of these areas were obviously in situations where the soil moisture content had remained sufficiently high to maintain plant growth, but a very striking thing was noticeable about the remainder, which comprised whole beds in which all of the plants appeared normally green. These beds were in the midst of other large areas in which all of the plants were dead, and they consisted of those plots which had not been sprayed at all during the season or had been treated with some compound other than Bordeaux mixture. With the exception of these few plots the entire area of each planting had been sprayed by the growers or the writers with three applications of a 3–4½–50 Bordeaux mixture (hydrated lime). In the check plot (nontreated) those plants that had not been affected by Alternaria blight were normal in color and form, as shown in figure 2, A, while those in immediately adjacent beds which had been sprayed with Bordeaux mixture were dry and dead, as in figure 2, B.

All the beds in which injury was noticeable as early as June 25 had received applications of Bordeaux mixture on May 15 and 31, respectively. This fact, connected with the observations made above, suggested the possibility that the mere presence of the Bordeaux residue on the ginseng leaves was in some way responsible for the injury starting as early as it did and becoming as severe as it finally was. That is, the Bordeaux must have exerted some accelerating influence on the transpiration rate of the plants. This increased transpiration rate, combined with the low soil moisture content and the high evaporating power of the air, placed a demand upon the water-absorption system of the plant which it was unable to meet. As a result the leaves passed through the successive stages of incipient drying, and transient and permanent wilting and, finally, under the influence of continuous conditions of desiccation they died and became dry.

The literature dealing with the effect of Bordeaux mixture upon plants is extensive and varied. In a discussion of the type of injury noted here on ginseng we are concerned chiefly with those papers which make reference to the water relations of the plant. For the purpose of discussion those which we shall consider may be roughly divided into five groups. The first group, which is not so directly pertinent as the rest, includes a few of the articles which discuss Bordeaux injury under certain types of weather conditions. The second includes those reporting a lowering of leaf temperatures; the third, a number which note a protective action against drouth; the fourth, those which indicate that transpiration rates are decreased; and, the fifth, those which show that the application of a Bordeaux spray to the leaves of a plant usually increases the rate of water loss.

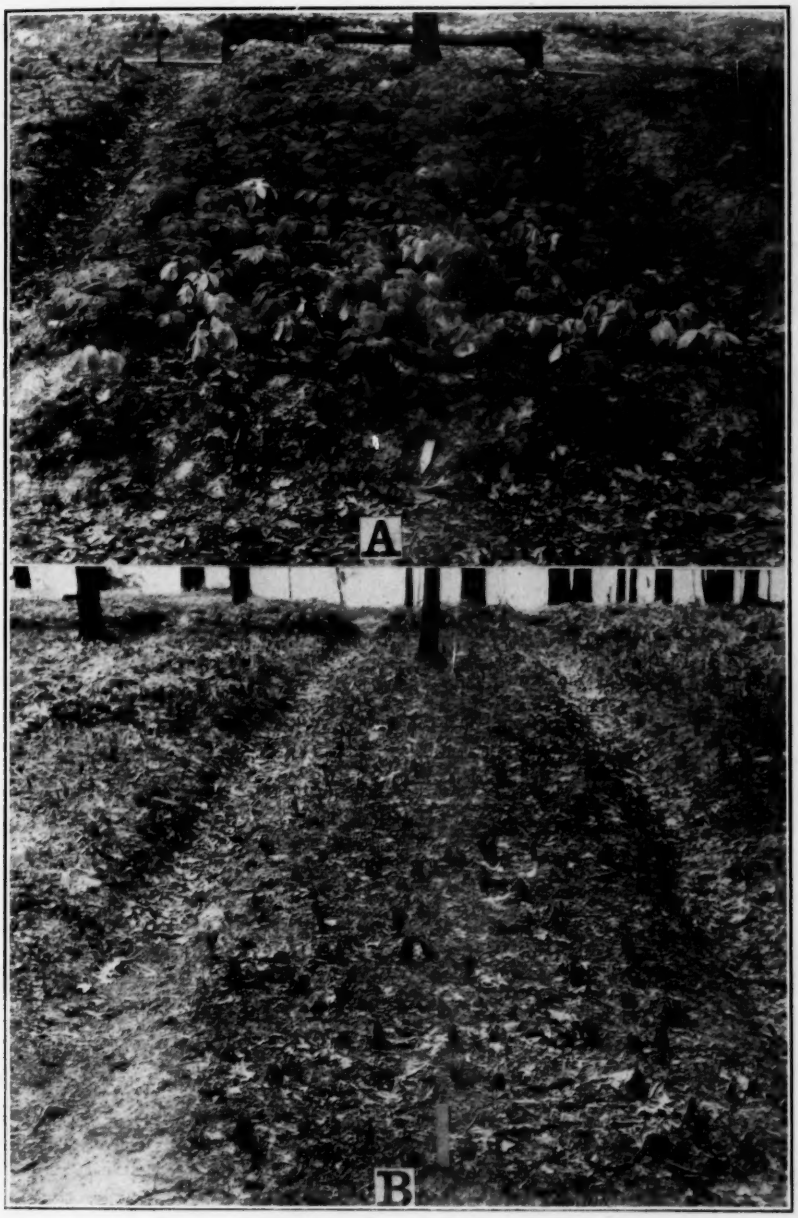

FIG. 2. A. Check plot. No spray. No drouth injury. B. Plot treated with 3–4½–50 Bordeaux mixture. Drouth injury.

Bain (1) found that peach trees sheltered from dew or rain or shaded were not affected by a Bordeaux spray which did injure those not so protected. Bonns (2) noted that wet weather following Bordeaux applications on apple trees increased leaf injury and that such factors as high atmospheric humidity and free water on the leaves were contributory. Crandall (6) reported Bordeaux injury as occurring regardless of the care used in the manufacture and application of the mixture if weather conditions, such as periods of rain or heavy dew formation, were just right following spraying. Hedrick (13) states that the kind of weather following an application is one of the factors determining the extent of Bordeaux injury and that alternating periods of rain and bright sunshine are most conducive to injury. Whetzel (23) reported injury to ginseng apparently due to the combination of a Bordeaux spray and cold weather. Many of the young plants were killed in this instance.

The type of injury made reference to in the above paragraph is most likely to occur when a spray application is followed by cool, wet weather or a series of heavy dews, possibly alternating with other periods of bright sunshine. The injury to ginseng in 1930 occurred during an extended period of dry, hot weather. Dew was not a factor since it did not form on these plants growing under trees. Also, the plants were shaded and rains were, of course, very infrequent. Thus, every factor cited as being contributory to the type of Bordeaux injury discussed in the previous paragraph was absent or opposite in occurrence, in the present case, and it therefore seems probable that the type and cause of the injury must have been quite different in the two instances.

Eaton and Belden (11), working with cotton, found that leaves covered with a coating of whitewash were about 3° C. cooler than nontreated checks. Lutman (14) found that a Bordeaux residue lowered the temperature of potato leaves from $\frac{1}{8}$ to $\frac{2}{3}$ of a degree Centigrade. Tilford and May (22) reported that a Bordeaux film lowered the internal temperature of a potato leaflet significantly below that of nonsprayed controls. An increase in the lime constituent further decreased the leaf temperature, while the addition of lampblack raised it to a point above that of the leaves on the control plants.

Lutman (15) found that the presence of a Bordeaux residue on potato plants afforded some degree of protection against that type of tipburn due to dry, hot weather, by virtue of its shading effect. Schander (20) also suggested a protection to plants from the same cause. Sturgis (21) regarded Bordeaux mixture as a beneficial factor, aiding plants to resist drouth injury during the drouth of 1894, in Connecticut, when the extreme heat and lack of soil moisture resulted in leaf burning of nonsprayed plants.

Clinton (5) attributed the increase in potato yields, which often results from the application of Bordeaux mixture in dry seasons, even in the absence of disease, to a decrease in the transpiration rate. Ewert (12) reported a decrease in transpiration rates following applications of Bordeaux; and Rumm (19), working with abscised stems of grape, found that those which had been sprayed with Bordeaux remained turgid longer than those not treated. Schander (20) also noted a lessening of transpiration due to spraying.

Bain (1) noted that peach seedlings, sprayed with Bordeaux, required watering more often than those not so treated. Butler (4) found that a coating of Bordeaux spray increased transpiration in a number of trials. Milk of lime also caused an appreciable increase. The more opaque the mixture the greater the acceleration observed. Most of the increase occurred during the night. Duggar and Cooley (7, 8), working with tomatoes, obtained an increase in the transpiration rate with Bordeaux films but not with a number of other sprays and dusts. Strong Bordeaux gave a greater acceleration than weaker mixtures. Some of the increases noted, as with Bordeaux mixture or this compound plus lampblack, were as great as 50 to 75 per cent over the control plants. High concentrations of Bordeaux induced incipient wilting and, even marginal leaf injury, in some instances. This effect was perhaps very similar to the ginseng injury observed in Ohio this year. Duggar and Bonns (9) in a study on potted potato plants found that most of the increase occurred during the night period. The increase ranged between 37 and 133 per cent over that of the controls. Increases as great as 479 per cent over the normal were noted for short intervals immediately following a spray application. Dutton and Wells (10) observed that cherries were often small on trees sprayed with Bordeaux mixture. Cherry shoots treated with Bordeaux lost water from 25 to 50 per cent faster than controls and the fruits became badly shrunken in a short time, thus indicating a removal of water from them by the rapidly transpiring leaves. Martin (16) applied Bordeaux mixture to abscised leaves and to potted plants and obtained a material increase in the rate of water loss. The increase was greatest during the first two hours after spraying. It also varied in degree for different species. Martin and Clark (17) sprayed potato plants growing in pots maintained at different soil-moisture contents with a 5–5–50 Bordeaux mixture. With high soil moisture the plants sprayed with Bordeaux lost 135 per cent more water than the controls during the night period and 81 per cent more during the day period. With low soil moisture the increases were 81 and 18 per cent, respectively. Zucker (24) found that Bordeaux increased transpiration on a variety of plants, while milk of lime was less effective in this respect.

It seems certain that the influence of the factors of low temperature, dew formation, and the alternation of rain and sunshine may be largely disregarded in conection with the type of injury noted in this instance. It is also very probable that no beneficial effect due to shading or decreased water loss existed since most of the plants were well shaded and only the sprayed ones showed injury. Thus, in view of the fact that a Bordeaux film on the leaves of a plant probably increases rather than decreases the transpiration rate and the further facts that the soil moisture content was low and the evaporation rate high, it seems very likely that the death of the sprayed plants was in some way brought about by the combined effect of drouth and spray which seriously disturbed the internal water relations of the plants. This conclusion is borne out by a number of observations made while the injury progressed in extent and severity. Of course, it is not definitely known whether the injury observed in this instance came about because of a greatly increased transpiration rate immediately following the application of May 31 or June 25, or both, as is suggested by the work of Duggar and Bonns (9) and Martin (16), or whether the effect was due to a cumulative action over a period of two or three weeks following the spray application. Many other species of plants in similar situations were suffering severely from a lack of water. The symptoms observed were those usually accompanying injury and death due to drouth. Most of the ginseng plantings in wood lots showed severe injury by the end of July, while those depending on lath shelters for shade were not affected and remained green until the usual time in the fall. In the wood lot plantings injury was first noticed in definitely delimited areas and all of the plants in these areas showed similar symptoms of injury within a very short time. These areas were always found to be low in soil moisture, either because of some peculiarity of surface conformation or near-by tree groupings or because they were places subjected to an amount of sunlight far above the average for the planting, as a whole. The subsequent increase in size and number of these areas of injury was definitely connected with a progressive decrease in the soil-moisture content. After 75 per cent of the plants in each of the two wood lots in question had succumbed there were still many small, isolated areas scattered about in which all of the plants were in good condition, even though they had received exactly the same spray and cultivation treatment as the rest of the planting. These areas, usually surrounded by dead or dying plants, were in favorable situations from the standpoint of soil moisture, such as at the foot of slopes or in slight depressions. Finally, what is perhaps most important, all of those beds that had not been sprayed with Bordeaux mixture, such as check plots, dusted plots, and those sprayed with compounds which left little or no visible residue on the leaves, remained in good condition until

the end of the season. These uninjured beds were surrounded on all sides by sprayed plots in which 100 per cent of the plants were dried up.

Thus, the situation may be summarized somewhat as follows: The moisture content of the soil in the wood lots became low in June and at certain times during this month and in July approached the wilting-point value. This, combined with the high evaporating power of the air, frequently resulted in a severe drying of the leaf tissues. Incipient and transient wilting began to occur, but those plants which had not been sprayed were always able to recover before permanent wilting was followed by death. However, the presence of the Bordeaux film on the leaves of the sprayed plants increased the water loss sufficiently at some time during the wilting process to exceed the critical point of desiccation and to render subsequent recovery impossible. Consequently death and drying-out of the tissue resulted. Those plants growing in dry soil areas or standing in greater than the average amount of sunlight were the first to succumb and were followed by others as the conditions affecting desiccation of the tissues became more severe.

LITERATURE CITED.

1. BAIN, S. M. The action of copper on leaves. Tenn. Agr. Exp. Sta. Bul. 15. (2) 1902.
2. BONNS, W. W. Orchard spraying problems and experiments. Me. Agr. Exp. Sta. Bul. 189. 1911.
3. BURNS, G. P. Weather conditions and plant development. Brooklyn Bot. Gard. Mem. **1**: 119–122. 1918.
4. BUTLER, O. R. Bordeaux mixture II. Stimulatory action. N. H. Agr. Exp. Sta. Tech. Bul. 21. 1922.
5. CLINTON, G. P. Spraying potatoes in dry seasons. Conn. Agr. Exp. Sta. Ann. Rpt. **1909–1910**: 739–752. 1911.
6. CRANDALL, C. S. Bordeaux mixture. Ill. Agr. Exp. Sta. Bul. 135. 1909.
7. DUGGAR, B. M., and J. S. COOLEY. The effect of surface films and dusts on the rate of transpiration. Ann. Mo. Bot. Gard. **1**: 1–22. 1914.
8. ————, and ————. The effects of surface films on the rate of transpiration: experiments with potted potatoes. Ann. Mo. Bot. Gard. **1**: 351–356. 1914.
9. ————, and W. W. BONNS. The effect of bordeaux mixture on the rate of transpiration. Ann. Mo. Bot. Gard. **5**: 153–176. 1918.
10. DUTTON, W. C., and H. M. WELLS. Some physiological effects of bordeaux. Proc. Amer. Soc. Hort. Sci. **20**: 277–281. 1924.
11. EATON, F. M., and G. O. BELDEN. Leaf temperatures of cotton and their relation to transpiration, varietal differences, and yields. U. S. Dept. Agr. Tech. Bul. 91. 1929.
12. EWERT, E. Der wechselseitige Einfluss des Lichtes und der Kupferkalkbrühen auf den Stoffwechsel der Pflanze. Landw. Jahrb. **34**: 233–310. 1905.
13. HEDRICK, U. P. Bordeaux injury. N. Y. (Geneva) Agr. Exp. Sta. Bul. 287. 1907.

14. LUTMAN, B. F. Some studies on bordeaux mixture. Vt. Agr. Exp. Sta. Bul. 196. 1916.
15. ————————. Tip burn of the potato and other plants. Vt. Agr. Exp. Sta. Bul. 214. 1919.
16. MARTIN, W. H. Influence of bordeaux mixture on the rates of transpiration from abscised leaves and from potted plants. Jour. Agr. Res. **7**: 529–548. 1916.
17. ————————, and E. S. CLARK. Influence of bordeaux mixture on transpiration. N. J. Agr. Exp. Sta. Ann. Rpt. **50**: 249–255. 1929.
18. POOL, R. J. Some effects of the drought upon vegetation. Science **38**: 822–825. 1913.
19. RUMM, C. Ueber die Wirkung der Kupferpräparate bei Bekämpfung der sogenannten Blattfallkrankheit der Weinrebe. Ber. Deut. Bot. Ges. **11**: 79–93. 1893.
20. SCHANDER, R. Ueber die physiologische Wirkung der Kupfervitriolkalkbrühe. Landw. Jahrb. **33**: 517–584. 1904.
21. STURGIS, W. C. Notes on the 'early blight' of potatoes. Conn. Agr. Exp. Sta. Ann. Rpt. **18**: 127–133. 1894.
22. TILFORD, P. E., and C. MAY. The effect of bordeaux mixture on the internal temperature of potato leaflets. Phytopath. **19**: 943–949. 1929.
23. WHETZEL, H. H., and J. ROSENBAUM. The diseases of ginseng and their control. U. S. Dept. Agr., Bur. Pl. Indus. Bul. 250. 1912.
24. ZUCKER, A. Beiträg zur direkten Beeinflussung der Pflanzen durch die Kupfer-Vitriol-Kalkbrühe. Thesis. Stuttgart. 1896.

ANTHRACNOSE OF STRAWBERRY CAUSED BY COLLETOTRICHUM FRAGARIAE, N. SP.

A. N. Brooks

INTRODUCTION

During the years 1926–1929 observations were made upon an anthracnose disease attacking strawberry runners. Although a survey made in 1926 of the fields in the central Florida strawberry-growing area showed that the disease was not widely distributed, surveys made during subsequent years showed a slight increase in the amount of the disease each year. In the year 1930 anthracnose was fairly well scattered throughout the central Florida area. In certain fields anthracnose has been present each year in such abundance that plant propagation has been a failure. The disease attacks mainly the runners and girdles them, thus cutting off the food supply to the young plants before they have rooted and become self-supporting. This reduction in the number of plants propagated is a serious loss to the Florida grower because he depends almost entirely upon the plants he can grow during spring and summer to supply him with plants for fall setting. Northern-grown plants cannot be shipped in satisfactorily at that time.

Briefly, the system of strawberry propagation practiced in Florida is as follows: Each year during February and March strawberry plants are secured from northern nurseries and set out in beds. By June these beds will be covered with runner plants which are removed and set out in other beds. By September these last beds will be covered with runner plants which are removed and set out in the fields where they grow and produce fruit from the last part of November until May, at which time they are plowed under. For every thousand plants which the grower secures from the North in February he raises 20 to 50 thousand plants for fall setting.

Outside of Florida anthracnose apparently has not been observed in any State of the United States. At any rate, reference to this disease has not been found in the literature. Halsted,[1] p. 327–328, in listing some strawberry diseases, mentioned an "anthracnose" caused by *Gloeosporium fragariae* (Lib.) Mont., but Wolf[2] gives this as a synonym of *Diplocarpon earliana* (Ell. & Ev.) Wolf, the organism causing leaf scorch of strawberry.

[1] Halsted, B. D. Report of the Botanist N. J. Agr. Exp. Sta. Rpt. 1893: 289–436.

[2] Wolf, F. A. Strawberry leaf scorch. Jour. Elisha Mitchell Sci. Soc. 39: 141–164. 1924.

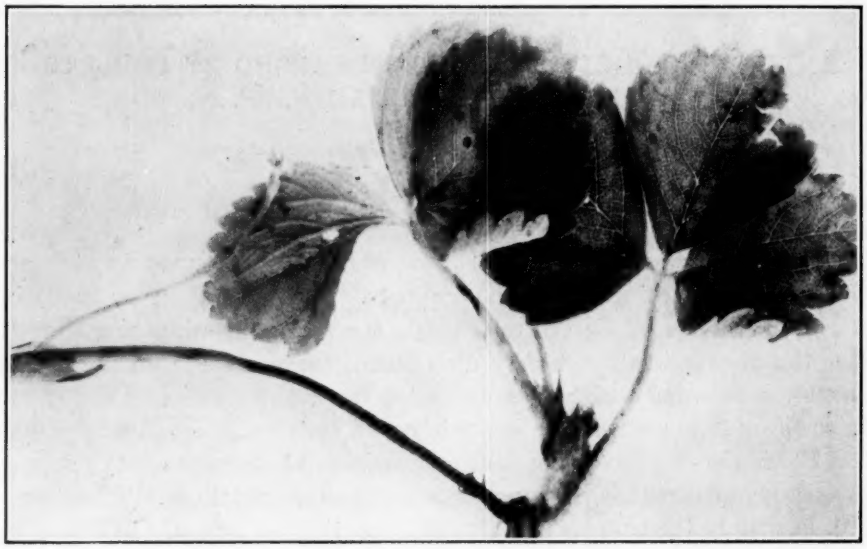

FIG. 1. Lesions on strawberry runner and petiole produced by *Colletotrichum fragariae* under field conditions.

THE DISEASE

Symptoms. Under field conditions anthracnose most commonly affects the runners, the petioles being affected occasionally. The young lesions are dark brown, oval, and 1 to 2 mm. long. They increase in size longitudinally for several centimeters and laterally until the runners are girdled (Fig. 1). Under favorable environmental conditions, high temperature and abundant moisture, these lesions may extend throughout the length of the runner. Ordinarily, however, the average lesion extends for 1 to 2 cm. along the runner and girdles it. These lesions are typically anthracnose-like, sunken, dark brown to black, and sharply demarcated from the surrounding healthy tissue. The cortex in the older portion of the lesion becomes shrivelled, and over its surface are scattered groups of setae which can readily be seen in profile with the aid of a strong hand lens. Microscopic mounts of strips of epidermis peeled from these lesions show a scattering of numerous acervuli, either bordered by or interspersed with dark brown setae (Fig. 2, A). Conidia are produced in abundance in the acervuli.

Seasonal Development. Anthracnose is most abundant in central Florida during the rainy season, June to September. It has been found as early as May, but it is not seen during the late fall and winter months because, at that time, the strawberry plants are kept free of all runners.

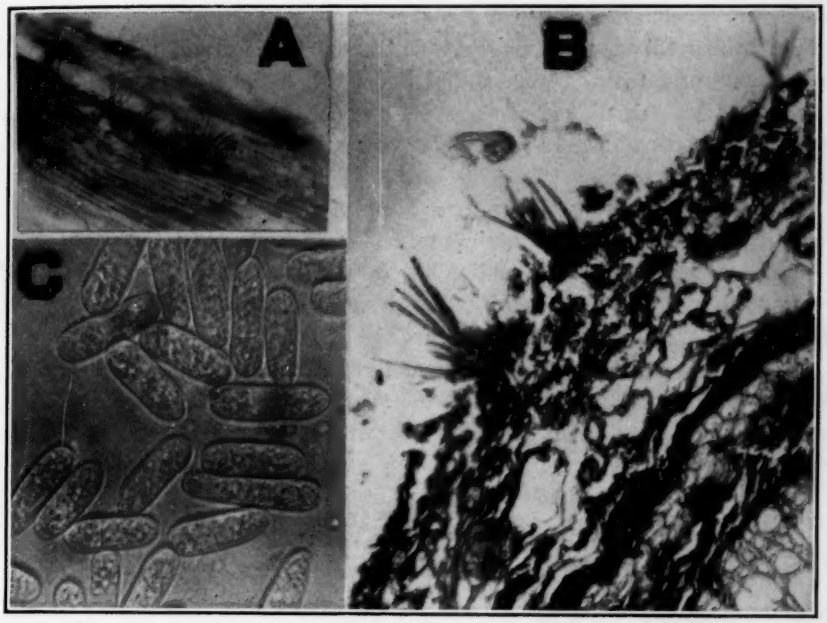

FIG. 2. Photomicrographs of *Colletotrichum fragariae:* A. Surface view of runner lesion, showing setae in acervuli. ×100. B. Cross-section of strawberry runner, showing disorganization of cortical cells caused by the fungus. ×200. C. Conidia. ×1,000.

In individual fields anthracnose shows up to a greater extent in the lower areas where water accumulates during heavy rains. Thus, surface water is one agency for the distribution of spores.

CAUSAL ORGANISM

Isolation. Suspensions of conidia from diseased runners were used for the first inoculation experiments from which typical symptoms of the disease developed upon healthy runners. Later, cultures of the organism were obtained upon lima-bean agar from single spores. In culture, conidia were produced abundantly in 6 to 8 days, and when used to inoculate healthy runners they produced a disease which compared exactly with that found under field conditions. The organism was reisolated from the artificially inoculated plants, grown in culture, and it again produced the disease when inoculated into healthy runners.

Cultural Characteristics. Pure cultures of the causal organism were grown on corn-meal, oatmeal, and lima-bean agars, each containing 1 per cent glucose. Inoculated agar plates showed growth within 12 hours, and the average rate of growth was 0.40 to 0.46 mm. per hour at atmospheric temperatures ranging between 75° and 90° F. Vegetative growth and production of conidia were scant upon corn-meal agar but more profuse upon oatmeal and lima-bean agar. The growth of the organism on all of these

media was black and zonate, with short, cottony, aerial hyphae, and the conidia appeared as pink masses. Cultures grown upon artificial media for a period of 6 months were found to have lost their pathogenicity.

Cultures on autoclaved string beans and strawberry runners gave an abundant growth of fairly long, cottony hyphae, with some production of conidia.

Taxonomy. Because of the symptoms of this disease and because it is caused by a species of Colletotrichum, the common name "anthracnose" is suggested, a term which the writer has applied to the trouble since its discovery and which will be retained since the "anthracnose" mentioned by Halsted is now called "leaf scorch."

The species of Colletotrichum causing anthracnose of strawberry runners has been compared with other described species of that genus and was found to differ from all of them. Host plants of species of Colletotrichum most like the one causing the strawberry anthracnose were inoculated with pathogenic cultures of the latter organism, but no infections resulted. The plants tested were alfalfa, hollyhock, red clover, snapdragon, spinach, and string bean.

A survey was made for wild hosts of the organism which causes strawberry anthracnose, but none has been found. Inoculations into the following plants failed to produce the disease: *Agrimonia* sp., blackberry, dewberry, *Gerardia* sp., *Ludwigia virgata* Michx.

Successful inoculations were made into runners of *Duchesnea indica* (Andr.) Focke.

No ascigerous stage of the fungus has been found either on host tissue or in culture. The strawberry anthracnose organism is therefore presented as a new species and the binomial *Colletotrichum fragariae* assigned to it.

Colletotrichum fragariae, n. sp.

Lesions brown to black, sunken, one to several centimeters long, girdling runner. Acervuli erumpent, scattered, mostly lenticular, 70–140 μ long by 30–60 μ wide (av. 110 x 40 μ). (Fig. 2, A, B, and 3, A.) Setae few to abundant, occurring singly or in groups, somewhat sinuous, 1 to 2 septate, 97–142 μ long by 3.8–5.4 μ wide (av. 115 x 4.3μ), dark brown and subbulbous at the base becoming lighter toward the apex, sometimes with a small, slightly constricted apical cell. (Fig. 3, B.) Conidia abundant, 14–21 μ long by 3.9–6.3 μ wide (av. 16.4 x 4.8 μ), spindle to boat-shaped with rounded ends, granular, 1 to 2-guttulate, pink in mass. (Fig. 2, C.) Conidiophores 5–10 μ long by 3–5 μ wide (av. 7 x 3.5 μ), hyaline, nonseptate, ovoid.

INFECTION EXPERIMENTS

Inoculation experiments were performed to determine the environmental conditions under which infection takes place and to determine whether leaves and petioles would become infected.

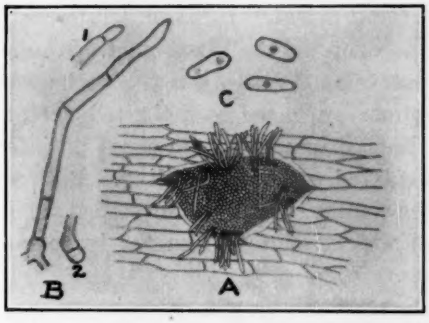

FIG. 3. Camera-lucida drawings of *Colletotrichum fragariae*, showing: A. Acervulus with arrangement of setae; B. Seta, with constricted apical cell (1) and subbulbous base (2); C. Conidia.

During September and October, 1927, runners on potted strawberry plants were inoculated with spore suspensions of the anthracnose organism. On one set of runners a fine needle was used to prick through the inoculum into the plant tissue; on the other set there was no mechanical injury made. Subsequent to inoculation, half of the plants of each set were placed in a moist chamber and half in partial shade in outside atmosphere. The results of these inoculations are summarized in table 1.

TABLE 1.—*Incubation period of Colletotrichum fragariae on strawberry runners, as affected by method of inoculation and treatment of plants subsequent to inoculation*

Method of inoculation	Treatment subsequent to inoculation	Incubation period—days
Inoculum pricked into epidermis	Placed in moist chamber	2– 3
	Placed in outside atmosphere and partial shade	5– 7
Inoculum placed on uninjured epidermis	Placed in moist chamber	6– 8
	Placed in outside atmosphere and partial shade	12–14

Another set of inoculation experiments was performed to determine the susceptibility of runners of different ages and portions of runners to anthracnose. From these experiments it was learned that the younger, more succulent runners or parts of runners were more readily invaded by the fungus than were the older ones, the tip of the runner being most susceptible. These results confirm observations which were made of the disease under field conditions.

Leaves and petioles of healthy strawberry plants also were inoculated. Some of the inoculations were made by placing a drop of spore suspen-

sion on the plant part and pricking through it into the plant tissues, others by merely placing the drop on the plant part. Runners were inoculated at the same time to serve as checks upon the pathogenicity of the culture used. Disease symptoms appeared to a limited extent on the leaves and petioles which had been injured, but no signs of infection developed on those which were inoculated without wounding. Both sets of runners which were inoculated under similar conditions developed symptoms of the disease. The causal organism was reisolated from the leaves and petioles showing the disease symptoms.

CONTROL

As has been stated previously, anthracnose girdles the runners and causes the death of the young plants which have not yet put out roots and become self-supporting. It thus causes considerable loss during the period of plant propagation—July through September. Applications of Bordeaux mixture 4–4–50, at 10-day intervals during the summer months have been found to check the progress of the disease but not to give complete control. The frequent rains at that time make control difficult.

Proper drainage of the strawberry nursery beds will help to check the spread of anthracnose.

Crop rotation may be an aid in combating this disease.

SUMMARY

(1) Strawberry anthracnose caused by a species of Colletotrichum has been found under field conditions mainly on the runners of this plant and only occasionally on petioles. It has been produced artificially upon petioles and leaves by inoculating through wounds.

(2) The disease has been observed only in the strawberry-growing area of central Florida.

(3) The disease is characterized by dark brown to black lesions on the runners. It causes considerable damage by girdling them and preventing the development of new plants.

(4) The causal organism has been isolated and its pathogenicity has been proved by Koch's postulates.

(5) The causal fungus is a species of Colletotrichum which is different from any known described species. A description of it is given under the proposed binomial **Colletotrichum fragariae,** n. sp.

(6) Bordeaux mixture 4–4–50, applied at 10-day intervals during the summer, checks the spread of the disease but will not completely control it, because of the abundant rainfall at that time.

DEPARTMENT OF PLANT PATHOLOGY,
FLORIDA AGRICULTURAL EXPERIMENT STATION,
GAINESVILLE, FLORIDA.

INFLUENCE OF MOSAIC INFECTION ON TOMATO YIELDS

J. W. Heuberger and A. J. Moyer[1]

INTRODUCTION

The literature relating to the mosaic disease of the tomato is replete with statements of observations on the reduction in yield being associated with time of infection. Gardner and Kendrick (1) state: "It is a matter of common observation that many plants infected early in the season may show very extreme effects of mosaic and bear no marketable fruit whatever. Others may bear a greatly reduced yield, while, in the case of plants infected late in the season, the effect on the yield is not very noticeable." In a later paper (2) these investigators again call attention to the fact that early infections cause the greatest loss. McKay (5) observed in Oregon, under both field and greenhouse conditions, that yields from mosaic-infected plants varied greatly, some yielding about a third of an average crop while others produced apparently an average yield. However, the literature reveals very little exact data upon the correlation of these losses with the time of infection. Norton (7) showed by measurements in the greenhouse that, although 33 per cent more fruit set on the plants longest remaining healthy, they produced very little more weight of fruit than plants infected earlier. McCubbin (4), under field conditions in Ontario in 1915, showed that 59 healthy plants gave 36.8 per cent more fruit and 40.5 per cent more weight of fruit than 59 mosaic plants. However, he does not state when his mosaic plants were infected. Unpublished observations made by J. B. S. Norton and R. A. Jehle during several years in Maryland tomato fields showed lower yields from the earlier infected plants. The investigations reported in this paper were undertaken with the object of obtaining more exact data on the effect of early and late infections of the common type of tomato mosaic on the yield of tomatoes under Maryland conditions. Two types of experiments are reported. One in 1927 showed the decreased yields based on the time of appearance of mosaic symptoms, and the other, in 1930, showed the decreased yields based on date of inoculation at definite growth stages.

METHODS AND RESULTS

1927 experiment: On July 1 a careful examination in a plot of Greater Baltimore tomato plants 6 to 8 inches tall, planted June 10, was made for individuals showing mosaic symptoms. The location of infected plants was

[1] The writers wish to acknowledge their indebtedness to Dr. J. B. S. Norton, under whose direction this work was done, for his valuable suggestions and criticisms.

recorded on a chart. Thereafter, 6 examinations at intervals of 1 week were made and, from the data obtained, 10 plants were selected from each weekly survey for yield studies. Harvests of ripe fruit were made at intervals of 1 week from August 22 to September 22, inclusive. Total yields for each of 6 series, based on the time of appearance of mosaic symptoms, were obtained. The average yield per plant for each series is presented in table 1. Under existing field conditions it was not possible to find by the first harvest 10 mosaic-free plants. Therefore, the yield of those plants which showed infection on August 12 was used as the basis for loss calculations. The 1927 growing season was approximately an average one.

TABLE 1.—*Summary of yield records of infected tomato plants comprising the 1927 experiment*

Time of appearance of symptoms	Number of plants	Average yield per plant in grams	Percentage loss due to mosaic
July 8	4	1,993	56.9
" 15	10	2,854	38.2
" 22	10	3,488	24.5
" 29	10	4,122	10.8
Aug. 5	10	4,532	1.9
" 12	10	4,621	.....

1930 experiment: Two series of 3 plots, each, were laid off side by side on a comparatively level piece of sandy loam soil. In each series 2 plots were planted to the Marglobe variety and 1 plot to the variety Greater Baltimore. Half of the plots of each variety was used for inoculations and the other half for controls. Similar fertilizer treatments and cultural practices were employed throughout.

Plants were obtained from beds apparently free from mosaic and were set on June 21 four feet apart in rows 4 feet apart. These plants were about a week older than the usual age for transplanting. The late planting was due to the fact that the soil was not previously available. During the transplanting process the hands of the workers were frequently washed with soap and water, and only strong, vigorous, healthy plants were set out.

All experimental inoculations were made by a slight modification of the needle-prick method devised by Holmes (3). Four inoculations were made during the growing season: the first, at transplanting time; the second, when the first flower cluster had formed; the third, when the first fruits

set were ½ to 1 inch in diameter; and the fourth, when the first fruits were ripe.

All precautions were taken to prevent the spread of mosaic by mechanical means. The field was inspected at weekly intervals for the appearance of cases of accidental infection and for the presence of aphids. Aphids were scarce throughout the season except for a small number being present just after the plants were set out. The accidental spread of mosaic was unusually slow and, at the end of the growing season, 51 plants in the control plots were still healthy. These accidental cases of infection are not included in the data.

Harvesting began on September 3 and continued until October 3. The yield records are summarized in table 2.

Drought conditions prevailed throughout the season and, for the months of June, July, August, and September, a deficiency of 11.01 inches of rainfall occurred, there being during this period only 29.47 per cent of the average rainfall.

TABLE 2.—*Summary of yield records of healthy and inoculated tomato plants comprising the 1930 experiment*

Date of inoculation	Number of plants used	Average number of fruits set per plant	Average yield per plant in grams	Percentage loss due to mosaic
First (6–26–30)	39	21	685	54.4
Second (7–11–30)	39	24	836	44.4
Third (8–14–30)	27	32	1,122	25.3
Fourth (9– 3–30)	13	32	1,335	11.2
Control plants	51	36	1,503	.....

In 1929 a preliminary test was made on the effect of mosaic on the quality of the canned fruit. Six cans each of healthy and mosaic fruit were prepared and then scored by an expert scorer, using the score sheet for canned tomatoes, tentative draft of January, 1928, of the National Canners Association. The differences between the healthy and mosaic cans were negligible.

DISCUSSION

Although these experiments were conducted under different climatic conditions, practically identical results were obtained. In 1927 the greatest loss in yield occurred with plants showing symptoms by July 8, while in 1930 the plants inoculated 5 days after transplanting produced a de-

cidedly lower yield than those inoculated later. In both experiments later infections produced similar results—the later the time of infection the less the reduction in yield. The results obtained show conclusively that the decrease in yield varies in direct relation to the earliness of infection. McMurtrey (6) and Valleau and Johnson (8), working with tobacco, obtained the same relation.

Although the results of the later infections show the same relation, they differ quantitatively in the 2 years, and these differences seem to bear a definite relation to cultural practices and climatic conditions. The plants used in 1927 were transplanted about 2 weeks earlier and were somewhat younger and smaller than those used in 1930. Hence, during the former season with approximately average rainfall the plants grew faster, matured fruit earlier, and produced greater yields than the 1930 plants, grown under drought conditions. These differences indicate that late infection of plants of retarded growth causes more damage than late infection of plants of average growth. For example, the figures in table 1 show only a 10.8 per cent loss when symptoms appeared on July 29, infection approximately 12 days earlier, while the figures in table 2 show that infection on July 11 resulted in a 44.4 per cent loss.

The figures presented in table 2, for the average number of fruits set per plant, show that the first two infections resulted in less fruit being set than the last two infections, while the healthy plants set the most fruit.

SUMMARY

Both experiments show that the early infections cause the greatest reduction in yield and that a direct relationship exists between the time of infection and the amount of reduction in yield. The figures presented in the tables show that the earliest infection in both experiments caused a reduction of over 50 per cent in yield, while the last infection caused a reduction in yield of 1.9 per cent in 1927 and 11.2 per cent in 1930.

Late infections in both experiments produced similar results, but the results differed quantitatively in the 2 years. A probable explanation is given for these differences.

DEPARTMENT OF PLANT PATHOLOGY,
MARYLAND AGRICULTURAL EXPERIMENT STATION,
COLLEGE PARK, MARYLAND.

LITERATURE CITED

1. GARDNER, M. W., and J. B. KENDRICK. Tomato mosaic. Purdue Univ. (Ind.) Agr. Exp. Sta. Bul. 261. 1922.

2. ————, and ————. Field control of tomato mosaic. Phytopath. **13**: 372–375. 1923.
3. HOLMES, FRANCIS O. Accuracy in quantitative work with tobacco mosaic virus. Bot. Gaz. **86**: 66–81. 1928.
4. MCCUBBIN, W. A. The diseases of tomatoes. Canada Agr. Exp. Farms Bul. 35. 1918.
5. MCKAY, MARION B. Mosaic diseases of tomatoes. Oregon Third Crop Pest and Hort. Rpt. 1915–20: 179–184. 1921.
6. MCMURTREY, J. E. Effect of the mosaic disease on yield and quality of tobacco with suggestions for control. Md. Agr. Exp. Sta. Bul. 302. 1928.
7. NORTON, J. B. S. Loss from mosaic disease of tomato. Phytopath. **4**: 398. 1914.
8. VALLEAU, W. D., and E. M. JOHNSON. The effect of a strain of tobacco mosaic on the yield and quality of burley tobacco. Phytopath. **17**: 523–528. 1927.

HETEROTHALLISM IN CORN RUST AND EFFECT OF FILTERING THE PYCNIAL EXUDATE[1]

GEORGE B. CUMMINS[2]

Since the presence of heterothallism in the Uredinales was discovered by Craigie (3) the question of just what takes place to cause the formation of aecia has remained unanswered. Craigie (4) subjected the pycnial exudate to a temperature of 70° C. and found that no stimulatory action was retained, the temperature supposedly being sufficient to kill the pycniospores. From this he concluded that the living pycniospores were essential. Arthur (2, pp. 242–243), in discussing the question, raised the valid objection that these results were inconclusive, as a temperature of 70° c. is considerably above that necessary to inactivate most enzymes. Since enzymes or similar substances are known to be present in the pycnial exudate, he suggested that these may furnish the necessary stimulation for aecia formation.

By the use of Craigie's methods, it has been found that corn rust, *Puccinia sorghi* Schw., which has as its alternate host, oxalis (*Xanthoxalis stricta* (L.) Small), is apparently heterothallic. In unpublished work Mains had previously reached the same conclusion. Oxalis plants were subjected to infection from suspended hibernated telial material and were then moved to cloth-covered cages to reduce the chance of contamination by insects after pycnial pustules appeared. Sterile needles were used to transfer exudate from one pustule to another. Of the 52 pustules treated by transfer of exudate, 39, or 75 per cent, formed aecia and 13 did not. Of the 42 pustules left untouched, 6, or 14.3 per cent, formed aecia and 36 did not. Thus, mixture of the pycnial exudates definitely stimulated aecia formation.

In order to determine whether or not the formation of aecia might be due to the presence of some enzyme in the pycnial exudate, the latter was filtered to remove the pycniospores. In preparation for this, two groups of oxalis plants were inoculated, one heavily, to serve as a source of exudate, and one very lightly. The lightly infected plants were immediately placed in cloth cages and kept separate from the heavily infected plants. When pycnial exudate became abundant, it was removed from the heavily infected plants by scraping the pustules with a flattened needle or a small scalpel. The exudate thus collected was mixed with a few cubic centi-

[1] Contribution from the Botany Department, Purdue University Agricultural Experiment Station, La Fayette, Indiana.

[2] The writer makes grateful acknowledgement to Dr. E. B. Mains for suggesting the problem and to Dr. J. C. Arthur for helpful criticism of the manuscript.

meters of distilled water to form a relatively concentrated mixture. Part of this was filtered through a small Berkefeld filter and the filtrate collected in a small glass vial.

Because of the small quantity of the mixture a modification of the usual method of filtering was employed. The method and the apparatus are essentially those of Martin, as described and illustrated by d'Herelle (6, pp. 22–23). A 2-inch Berkefeld filter of small diameter was suspended in a 250 cc. evacuation flask and the metal shaft was inserted into a small rubber stopper, which, in turn, could be inserted into a glass tube of suitable diameter. This tube was run through a rubber stopper of the size required by the flask. A small vial was tied over the lower end of the filter and the mixture was poured into the filter through the glass tube. By applying suction a small amount of the mixture could readily be filtered. In order to insure the efficiency of the filter, it was tested with a bacterial suspension. To accomplish this the entire apparatus was sterilized in the autoclave; the bacterial suspension was then filtered and the filtrate plated under sterile conditions. The fact that no bacterial colonies developed on the agar plates was considered sufficient proof that the apparatus was filtering properly. The filtered pycnial exudate was carefully examined with a microscope and no pycniospores were found.

On the lightly infected group of oxalis plants certain isolated pustules, presumably of monosporidial origin, were treated with the filtered exudate and others with the nonfiltered exudate. The exudate was applied with needles that were sterilized between each operation. The plants were then kept in cages until aecial counts were possible. Of the 10 pustules treated with the nonfiltered exudate all produced aecia in the usual time, as would be expected, since the mixture contained exudate from many pycnia. Of the 28 pustules treated with the filtered exudate none showed aecia in the usual 10-day period but 8 developed scattered aecia when held for an additional 1 to 3 weeks, though the aecia which actually opened and discharged spores usually were few and scattered on any one area.

Why 8 of the pustules treated with the filtered exudate produced aecia is unknown, but in all such experiments on the rusts a few scattered aecia have appeared where they were not expected, especially if held beyond the time required for normal aecia formation. Craigie (5) found that delayed development of aecia in nontreated pycnial pustules in *Puccinia graminis* Pers. was not uncommon, and Allen (1) reports irregular appearance of aecia in otherwise sterile pustules.

The results here reported indicate that *Puccinia sorghi* is heterothallic and that the formation of aecia cannot be explained on the basis of an enzymatic stimulation, as the pycnial exudate, which was freed from

pycniospores without inactivating its enzymes, lost its stimulatory action, and therefore substantiate Craigie's conclusion that the presence of living pycniospores is essential.

PURDUE UNIVERSITY,
LA FAYETTE, INDIANA.

LITERATURE CITED

1. ALLEN, RUTH F. A cytological study of heterothallism in *Puccinia graminis*. Jour. Agr. Res. **40**: 585–614. 1930.
2. ARTHUR, J. C., F. D. KERN, C. R. ORTON, F. D. FROMME, H. S. JACKSON, E. B. MAINS, and G. R. BISBY. The plant rusts. 446 pp. John Wiley and Sons, New York, and Chapman & Hall, London. 1929.
3. CRAIGIE, J. H. Experiments on sex in rust fungi. Nature **120**: 116–117. 1927.
4. ————. Discovery of the function of the pycnia of the rust fungi. Nature **120**: 765–767. 1927.
5. ————. On the occurrence of pycnia and aecia in certain rust fungi. Phytopath. **18**: 1005–1015. 1928.
6 HERELLE, F. D', and GEORGE H. SMITH. The bacteriophage and its behavior. 629 pp. Williams & Wilkins, Baltimore. 1926.

NEW OR UNUSUAL SYMPTOMS OF VIRUS DISEASES OF RASPBERRIES

GEORGE L. ZUNDEL

While working on the control of virus diseases of raspberries in Pennsylvania, some unusual reactions have been encountered, which, it seems to the writer, may be of more than passing interest.

In the spring of 1929, the raspberry patch of A. S. Seip, Wernersville, Pa., showed in an old planting of Cumberland raspberries an unusual type of mosaic to which the writer has since applied the term "fern-leaf" mosaic. The leaves were dwarfed and the tissue between the veins was wrinkled and unusually dark green. The serrations of the leaflets were accentuated, giving them a fern-leaf appearance. All parts of the infected plants, including the canes, were very brittle, and the plant appeared much dwarfed. The general appearance of such a plant is shown in figure 1, A.

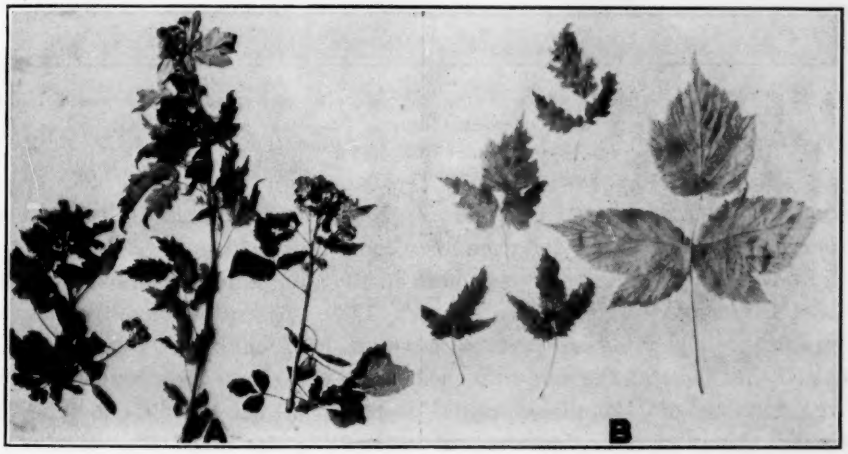

FIG. 1. "Fern-leaf" of raspberry. A. Diseased twigs. B. Diseased leaves compared with a healthy leaf.

In figure 1, B, is shown the relative size of diseased and healthy leaves. The fruit also was dwarfed, dry, crumbly, and tasteless.

Mr. Seip is the only farmer in his locality who grows melons and cucumbers. For several years past his cucurbit patches have been adjacent to the infected raspberry patch. It is therefore suspected that the fern-leaf symptom is the result of infection of the raspberries by the virus

of cucurbit mosaic. This assumption is based upon the fact that Mogendorff[1] has recently proved that fern-leaf mosaic of tomatoes is caused by the transfer of cucurbit mosaic to tomato plants. The similarity of the symptoms on the raspberry and on the tomato will be seen by comparing figure 1, A, with figure 2, A, which is a photograph of fern-leaf mosaic of

FIG. 2. "Witches'-broom" of respberry. A. General appearance of diseased plant. B. Showing detail of "witches'-broom" together with abnormal amount of foliage.

tomatoes collected in the greenhouse of the Pennsylvania State College from a plant adjacent to the cucumber bed.

Another interesting case was found in the Cumberland raspberry patch of John G. Dietz, Ridgway, Pa., July 24, 1930. Attention was attracted to a single plant having an unusual amount of foliage. An examination showed that most of the side branches of the canes had been replaced by a large number of "spindle sprouts" forming a witches'-broom type of growth. Many of the spindle sprouts were 12 inches long. The plant was 3 feet tall and had produced an unusually large crop of dry, bitter berries which had entirely lost all normal flavor. The canes had the characteristic blue color, and many of the leaves showed the usual downward curling of the tips also characteristic of streak. While witches'-brooms have never been described in connection with streak, it seems probable from the color of the canes and the leaf character that this is merely an unusual manifestation of the streak virus. Mottling of the leaves was not very evident.

[1] Mogendorff, N. "Fern-leaf" of tomato. Phytopath. 20: 25–46. 1930.

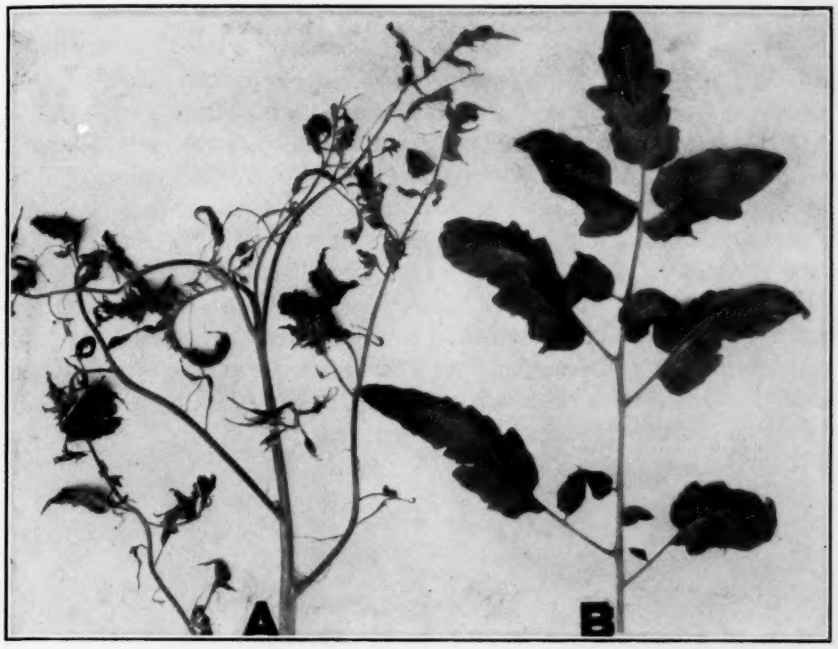

FIG. 3. "Fern-leaf" of tomato. A Diseased branch. B. Healthy leaf.

Figure 3, A, shows the general appearance of the plant; figure 3, B, shows the witches'-broom growth, together with the unusually abundant foliage.

THE PENNSYLVANIA STATE COLLEGE,
STATE COLLEGE, PENNSYLVANIA.

PHYTOPATHOLOGICAL NOTES

Tylenchus dipsaci on Hypochaeris radicata in Hawaii.—The bulb- and stem-infesting nematode *Tylenchus dipsaci* was reported by Godfrey and McKay[1] on *Hypochaeris radicata* along the Pacific Coast, all the way from Washington into California. More recently (1926 and 1928) the writer has found it on this same weed on the lawns at the University of California. In the fall of 1930 this plant occurred in great abundance in meadows at Olinda, Maui, on the slopes of Haleakala, at an altitude of 4,000 feet. A casual observation disclosed the fact that more than 50 per cent of the plants examined were heavily infested with the stem nematode. (Identification of the organisms was verified by examinations in the laboratory.) Typical swellings were found in leaf blades and midribs and in flower

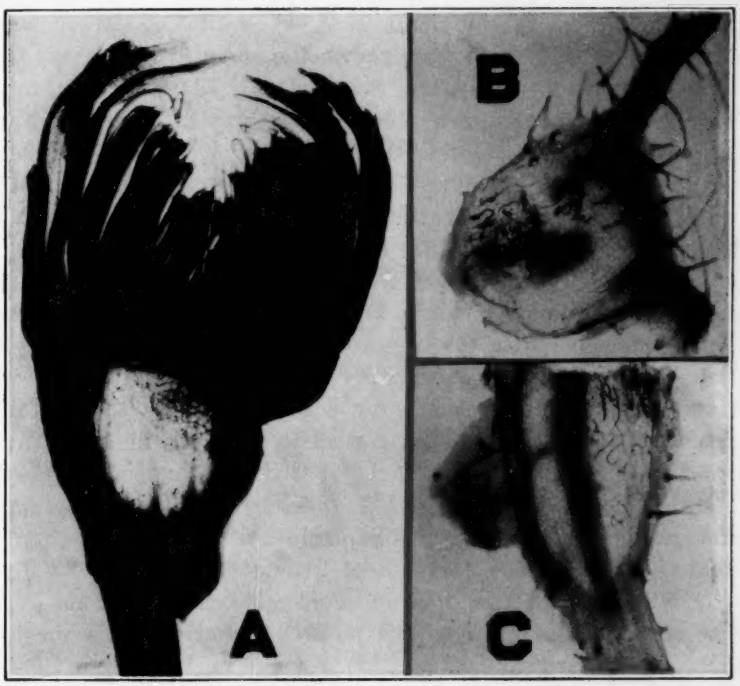

FIG. 1. *Tylenchus dipsaci* in *Hypochaeris radicata.* A. Longitudinal section through a flower head, showing heavy infestation with nematodes within and beneath the receptacle. B. Section through a swelling on the side of a leaf midrib, showing a "pocket" of nematodes within the leaf tissues. C. Section showing a similar pocket in the leaf mesophyll. All materials killed in Flemming's solution and cleared in clove oil, to show nematodes in their natural position.

[1] Godfrey, G. H., and M. B. McKay. The stem nematode, *Tylenchus dipsaci*, on wild hosts in the Northwest. U. S. Dept. Agr. Bul. 1229. 1924.

peduncles. Many infested flower heads were found, as with those reported by Godfrey,[2] in this plant and in true dandelion, *Taraxacum officinale*. There is little doubt that extensive distribution in the infested region has occurred by means of seed transmission. Whether or not original infestation came to the Islands by this means is an interesting conjecture. The accompanying photographs of plant materials killed with Flemming's solution and cleared in clove oil show to good advantage the nature of the nematode infestation.—G. H. GODFREY, Experiment Station, Association of Hawaiian Pineapple Canners, Honolulu, T. H.

PROFESSOR McGINTY *RE* PHARMACIEN FRECHOU[1]

Among the papers published in PHYTOPATHOLOGY occasionally there is one which strengthens the conviction that, while some of the older generation of mycologists may have been shown the error of their ways through the pointed comments of my late friend C. G. Lloyd, our more recent workers, alas, require a like discipline. For example, in the April number there is a brief note by a William H. Weston, Jr., written in a style tinged here and there with unseemly frivolity and showing greater interest in the merely human than in the scientific aspects of investigation, which begins with the sentence "It was in 1878 and 1879 that *Sclerospora graminicola* (Sacc.) Schroet. was first reported from Italy, from France, and from Germany." Now I do not know much about this writer, save that he apparently is afflicted with the urge to add his name to species of Sclerospora, but I notice that he is quite ready in this note to criticize the work of others and so he should welcome my calling attention to the following facts in connection with his opening sentence. It was in 1876 that P. A. Saccardo in his "Fungi Veneti Novi Vel Critici," Series 5, in the Nuovo Giornale Botanico Italiano 8, p. 172, described *Protomyces graminicola* which had been collected at Selva in September, 1875, on *Setaria verticillata* and listed as No. 496 in his "Mycotheca Veneta"; while, in 1875, J. Urban in Lichterfelde, near Berlin, had collected similar material on *S. viridis* which he sent to P. Magnus with a letter of description on the basis of which Magnus described *Ustilago* (?) *Urbani* in 1879; and in August, 1877, at Frederickshain, near Berlin, E. Ule collected the same fungus which was issued under *U. Urbani* of Magnus as No. 2498 of Rabenhorst's "Fungi Europeae."

[2] Godfrey, G. H. Dissemination of the stem and bulb infesting nematode, *Tylenchus dipsaci*, in the seeds of certain composites. Jour. Agr. Res. 28: 473–478. 1924.

[1] Published at the expense of William H. Weston, Jr., out of the order determined by the date of receipt of the manuscript.

Moreover, even though Weston, in 1921, had indeed called attention in his paper on "Production and Dispersal of Conidia etc." to Prillieux's report of germination, he seemed to have forgotten his own reference to it by 1928, for in the Journal of Agricultural Research, June, 1928, in connection with the downy mildew on Everglade millet in Florida, he says (p. 954) of the oospores of *Sclerospora graminicola*, "The part these spores play in the life history of the fungus has not been worked out in all its details and the actual method of germination has not been reported or investigated." It would be better for mycology if writers such as the one in question paid more attention to strict accuracy in the details of their publications rather than to imaginative speculations as to the activities of pharmacists long since dead.—PROFESSOR ALOYSIUS T. MCGINTY.

The renewal of Professor McGinty's activities should be hailed with interest and enthusiasm by all mycologists and plant pathologists. In this instance his criticism is entirely just.—WILLIAM H. WESTON, JR., Laboratories of Cryptogamic Botany, Harvard University.

Occurrence of Cadophora fastigiata in Canada.—In their work on blue stain in pine and spruce in Sweden, Lagerberg and Melin[1] describe for the first time the fungus *Cadophora fastigiata* L. et M., nov. gen. et sp., and report its widespread occurrence in that country as a causal agent of blue stain in softwoods. Otto Kress *et al.*,[2] in their study of decay in pulp, had previously described and figured an unnamed fungus which they had frequently found causing grey spotting of ground wood and sulphite pulps in the United States. Lagerberg and Melin consider this fungus to be identical with their *C. fastigiata*. The fungus is represented, therefore, in both Europe and America.

Cadophora fastigiata has recently been isolated by the writer from stained sapwood obtained in Canada from the following species: White spruce, *Picea canadensis* (Mill.) B. S. P.; white pine, *Pinus strobus* Linn.; jack pine, *P. Banksiana* Lam.; and Douglas fir, *Pseudotsuga taxifolia* (Lam.) Britton.

When grown in pure culture on sapwood blocks of white pine, *Pinus strobus*, and red pine, *P. resinosa* Aiton, *Cadophora fastigiata* produced an intense grey-green stain. It also stained to some extent culture blocks of black spruce, *Picea mariana* (Mill.) B. S. P., sapwood.

It is very probable that fungus is responsible for a considerable amount of the sapwood stain found in Canadian softwood lumber.—E. A. ATWELL, Forest Products Laboratories of Canada, Ottawa, Canada.

[1] Lagerberg, T., G. Lundberg, and E. Melin. Biological and practical researches into blueing in pine and spruce. Svenska Skogsvårdsför. Tidskr. **25**: 145–272. 1927.

[2] Kress, Otto, *et al.* Control of decay in pulp and pulpwood. U. S. Dept. Agr. Dept. Bul. 1298. 1925.

Maximov, N. A. A Textbook of Plant Physiology. Edited by A. E. Murneek and R. B. Harvey. vii–xvi + 381 pp., 152 figs. Edition I. McGraw-Hill Book Company, Inc., New York and London. 1930.

This English translation of the first edition of Dr. N. A. Maximov's "Textbook of Plant Physiology" constitutes an interesting addition to our relatively few texts on plant physiology. Dr. Maximov is a professor in the Pedagogical Institute of Leningrad and Director of Plant Physiology of the Bureau of Applied Botany, U. S. S. R. His world-wide recognition as an authority on the ecological relations of plants, especially in the field of water relations and drought resistance, makes his book of more than ordinary interest.

Following an introduction that points out the close interrelationships of plant physiology with other sciences, both fundamental and applied, there are four major divisions. The first, entitled "Absorption of Matter and Energy," deals with the plant's synthesis of organic compounds from inorganic materials. The sources and utilization of carbon and nitrogen and of mineral elements are discussed in the three chapters of this section. The second major division, "Water Relations of the Plant," is of special interest, embodying the results of the author's distinguished contributions to knowledge in this field. After a chapter dealing with the concept of the cell as a colloidal osmotic system, there are three chapters dealing with the absorption, loss, and translocation of water in the plant. The third division, "Utilization of Reserve Products and Liberation of Energy," begins with a chapter dealing with the storage of substances in seeds and other organs, their mobilization through the agency of enzymes, their utilization in the production of new living matter, and their deposition as food reserves in the seed at the end of the cycle. The second chapter in this section deals with respiration. The fourth and final major division, "Growth, Movement, and Reproduction," carries the story through the outward manifestations of the absorption, production, and utilization of nutritive substances.

This text has many advantageous features that will recommend it to certain groups. It seems specially adapted to those whose primary interests are in the field of ecology rather than in the physico-chemical aspects of plant physiology. The data and illustrations are frequently drawn from the fields of agriculture and forestry, and the text emphasizes the applications of theory to the applied science. There is a very thorough treatment of the water relations of plants, including an exposition of the fundamental properties of colloids. There are excellent discussions of drought and of

cold resistance and of the practical problems of plant propagation. Phytopathologists will find good discussions of the physiology of parasites and saprophytes.

There seem to be no serious criticisms to be made of the content of the book. Some subjects receive scantier attention than those specially interested in them might wish, such as physiological correlation, photoperiodism from the standpoint of its formative effects on growth, and the significance and nature of the buffer system or acid-regulating mechanism in plants. Those who do not favor the assumption of special hormones to explain the different physiological processes involved in growth and reproduction will criticise the frequent occurrence of this word in the last three chapters of the book. On the whole, there is considerable reserve in referring to the newer contributions, although half a page is devoted to a discussion of the unsubstantiated work of Popoff on growth stimulants.

A few inaccurate statements might be noted here. On page 126 typographical errors are probably responsible for the omission of minus signs in the statements that winter cereals are able to stand 15 to 20° C. and that certain dormant organs, including the needles of conifers, freeze at 15 to 20° C. A misplaced semicolon in the third sentence on page 95 is responsible for an unfortunate ambiguity. In the discussion of amylose (p. 204) the characteristics of the two forms, α and β, have been confused. The relatively insoluble "skeleton" of the starch grain which gives a violet color with iodine is known as α-amylose or amylopectin, while the β-amylose is the more soluble "basic mass" of the grain. On page 345, the use of the words "struggle" and "antagonism" would seem to convey an improper conception of the chemical interrelationships involved in the transition from vegetative to reproductive phases of growth. On page 69 the author doubtless meant to say that the inorganic phosphorus in the plant is largely in the form of phosphates, not free phosphoric acid.

On the whole, the text is well organized and interestingly written, although its usefulness would be increased by a more complex index. For instance, casual inspection has shown that the subjects of aluminum and iron availability, amylose, hydrogen-ion concentration in plants, and at least six references to hormones are not included in the index.

The illustrations are not very good. The half tones are mediocre, and the drawings, often redrawn from other sources, are poorly executed. Also, some of the illustrations are inadequately explained.

From the reviewer's point of view, a fault in the book lies in its failure to include citations to literature. Of the authorities mentioned by name, many are Russian. Complete citations to this literature would add to the value of the book to investigators, but the absence of even a date to

help locate these sources distinctly lessens the usefulness of the book in this respect. At the head of the scanty list of reference books and periodicals, it is stated that those in Russian are omitted because students in elementary plant physiology are not as a rule prepared to read effectively scientific articles in a foreign language. Many will doubt whether the omission of citations to this literature, specifically referred to in the introduction by the editors as a "pedagogical merit," is desirable. It would seem that a student mature enough to be in a university course would not have his attention unduly distracted by references to literature.

While the author shows himself in sympathy with the immediate problems of crop improvement, at the same time he is obviously aware of the value of fundamental discoveries such as those being made in the fields of theoretical physics and chemistry. References to the quantum theory in the discussion of the mechanism of photosynthesis, to the Donnan theory of membrane equilibrium to explain the entrances of substances from the soil into roots, and the application of the facts of colloid chemistry to the problems of the water relations of plants are typical of discussions which indicate his familiarity with the recent concepts of the analytical as well as the descriptive phases of plant physiology. While it may be said that some of the discussions are characterized by overemphasis of the author's own point of view, it should be added that on more than one of the moot questions he has qualified himself to speak with authority.—ANNIE M. HURD-KARRER, Bureau of Plant Industry, Washington, D. C.